Vol. XIII MAY, 1950 No. 2

SOCIOMETRY

A Journal of Inter-Personal Relations

A QUARTERLY

SUBSCRIPTION $7.00 YEARLY FOREIGN POSTAGE $1.00 ADDITIONAL

CURRENT SINGLE ISSUES $2.50
CURRENT DOUBLE ISSUES $5.00
SINGLE BACK ISSUES $3.00
DOUBLE BACK ISSUES $6.00

Any issue is current until the following issue is off the press. Thereafter it becomes a back issue.

Make checks payable to Beacon House, Inc.

Membership dues in the American Sociometric Association are $6.00 including subscription to this journal or to Group Psychotherapy.

Published quarterly by Beacon House, Inc., at Beacon, N. Y., in February, May, August and November. Address all communications to: Beacon House, Inc., Beacon, N. Y., or 101 Park Avenue, New York 17, N. Y. Re-entered as second class matter, October, 1943, at the Post Office at Beacon, New York, under the act of March 31, 1879.

SOCIOMETRY

A Journal of Inter-Personal Relations

Vol. XIII MAY, 1950 No. 2

EDITORIAL COMMITTEE

J. L. MORENO, Chairman
Sociometric Institute
New York

HELEN H. JENNINGS, Editor
Center for Human Relations Studies
New York University
New York

JOAN H. CRISWELL, Managing Editor
Bureau of Naval Personnel
Washington, D. C.

EDITORIAL BOARD

JOHN DEWEY
Columbia University
(Philosophy and Education)

GEORGE GALLUP
American Institute of
Public Opinion

GARDNER MURPHY
College of the City of New York
(Psychology)

GEORGE P. MURDOCK
Yale University
(Anthropology)

ERNEST W. BURGESS
University of Chicago
(Sociology)

SOCIOMETRY

A Journal of Inter-Personal Relations

Vol. XIII MAY, 1950 No. 2

CONTRIBUTING EDITORS

GORDON W. ALLPORT
Harvard University

HOWARD BECKER
University of Wisconsin

MERL E. BONNEY
North Texas State College

HADLEY CANTRIL
Princeton University

F. STUART CHAPIN
University of Minnesota

LEONARD S. COTTRELL, Jr.
Cornell University

STUART C. DODD
University of Washington

JOSEPH K. FOLSOM
Vassar College

GEORGES GURVITCH
University of Paris

HENRIK INFIELD
Group Farming Research Institute
Poughkeepsie, New York

WILLIAM H. KILPATRICK
Teachers College
Columbia University

PAUL F. LAZARSFELD
Columbia University

NOLAN D. C. LEWIS
New York State Psychiatric Institute

EDUARD C. LINDEMAN
New York School of Social Work

RONALD LIPPITT
University of Michigan

CHARLES P. LOOMIS
Michigan State College

GEORGE A. LUNDBERG
University of Washington

ROBERT S. LYND
Columbia University

MARGARET MEAD
American Museum of
Natural History

ZERKA T. MORENO
Psychodramatic Institute
Beacon, New York

THEODORE M. NEWCOMB
University of Michigan

MARY L. NORTHWAY
University of Toronto

MARIA ROGERS
Committee on Autonomous Groups

IRWIN T. SANDERS
University of Kentucky

FRANK STANTON
Columbia Broadcasting System

SAMUEL A. STOUFFER
Harvard University

CARL C. TAYLOR
U. S. Department of Agriculture

LESLIE D. ZELENY
Colorado State College of Education

FLORIAN ZNANIECKI
University of Illinois, Urbana

SOCIOMETRY

A Journal of Inter-Personal Relations

Vol. XIII MAY, 1950 No. 2

CONTENTS

NOTES ON THE CONSTANT FRAME OF REFERENCE PROBLEM—Joan H. Criswell 93

PUNCHED CARD TECHNIQUE FOR THE ANALYSIS OF MULTIPLE LEVEL SOCIOMETRIC DATA—Leo Katz 108

POPULATION, DISTANCE AND MIGRATION FROM KENTUCKY—Fred L. Strodtbeck 123

A SIMPLIFIED EXAMPLE OF THE USE OF MATRIX MULTIPLICATION FOR THE ANALYSIS OF SOCIOMETRIC DATA—James Chabot 131

A METHOD FOR ANALYZING THE SOCIOMATRIX—Corlin O. Beum, Jr. and Everett G. Brundage 141

AN ADAPTATION OF HOLZINGER'S B-COEFFICIENTS FOR THE ANALYSIS OF SOCIOMETRIC DATA—R. Darrell Bock and Suraya Zahid Husain 146

RACIAL ATTITUDES OF CHILDREN—Marion Radke and Jean Sutherland and Pearl Rosenberg 154

THE SOCIOMETRIC APPROACH TO SOCIAL CASE WORK—J. L. Moreno .. 172

NOTE ON COHESION IN SOCIAL GROUPS—J. L. Moreno 176

A REVIEW OF "SOCIOMETRY IN FRANCE AND THE UNITED STATES" ... 177

SOCIOMETRICALLY-ORIENTED LITERATURE 179

ANNOUNCEMENTS 180

MORENO INSTITUTE 186

The Editor of this issue, Dr. Leo Katz, has made a brilliant effort to round up a number of contributions which push forward our knowledge of statistical techniques. With the spreading interest in group methods and group psychotherapy the rapid analysis of a large mass of data has become imperative.

The Editor of the next issue of SOCIOMETRY, which is the Yearbook for 1950, is Dr. Ralph Spence, Teachers College, Columbia University.

Editorial Committee

NOTES ON THE CONSTANT FRAME OF REFERENCE PROBLEM[1]

JOAN H. CRISWELL

Bureau of Naval Personnel,[2] Washington, D. C.

In recent years articles have appeared which purport to provide sociometric measurement with formulas for a "constant frame of reference" otherwise lacking, so that "conclusions may take their place in an integrated scheme of scientific measurement" (2, 7). A hope recently expressed by one of these writers was that these formulas would "invoke opinions from field workers regarding the possibility of their practical application" (7, p. 379). It seems high time to accept this invitation.

The creation of a constant frame of reference by Bronfenbrenner (2) and Edwards (7) has in general been an effort to produce standard group measures by applications of probability theory. Both contributions cited represent a great deal of thought and effort devoted to developing mathematical treatment of sociometric findings. Helpful points are made and these will be treated later. Even incorrect concepts are plausibly presented. The present writer once regarded Bronfenbrenner's procedure for scoring individual social status as promising (4), and Loomis and Pepinsky found "important" his method of testing the significance of individual scores (8, p. 262). Actually, a variety of misconceptions characterize both the Bronfenbrenner treatment of individual social status and his treatment of group structural aspects such as cleavage. But so subtle has been the misuse of well-known concepts and so elegant the mathematical language employed that it is most difficult to trace out the substructure of reasoning supporting the conceptual framework.

The present paper attempts therefore to separate out some of the flaws which weaken the constant frame and will suggest the sort of method that may prove more appropriate. It is realized that no statement in statistical theory can be definitive and that any current group measurement techniques are only a crude beginning in a new and rapidly developing field. In such a field, controversy among writers and frequent change of opinion is to be expected. But the problems here discussed seem particularly necessary to

[1] For valuable statistical advice rendered throughout the preparation of this article the author is indebted to Mr. Frank Gross, research statistician, Bureau of Naval Personnel.

[2] The opinions and assertions in this paper are those of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

The Editor of this issue, Dr. Leo Katz, has made a brilliant effort to round up a number of contributions which push forward our knowledge of statistical techniques. With the spreading interest in group methods and group psychotherapy the rapid analysis of a large mass of data has become imperative.

The Editor of the next issue of SOCIOMETRY, which is the Yearbook for 1950, is Dr. Ralph Spence, Teachers College, Columbia University.

Editorial Committee

NOTES ON THE CONSTANT FRAME OF REFERENCE PROBLEM[1]

JOAN H. CRISWELL

Bureau of Naval Personnel,[2] Washington, D. C.

In recent years articles have appeared which purport to provide sociometric measurement with formulas for a "constant frame of reference" otherwise lacking, so that "conclusions may take their place in an integrated scheme of scientific measurement" (2, 7). A hope recently expressed by one of these writers was that these formulas would "invoke opinions from field workers regarding the possibility of their practical application" (7, p. 379). It seems high time to accept this invitation.

The creation of a constant frame of reference by Bronfenbrenner (2) and Edwards (7) has in general been an effort to produce standard group measures by applications of probability theory. Both contributions cited represent a great deal of thought and effort devoted to developing mathematical treatment of sociometric findings. Helpful points are made and these will be treated later. Even incorrect concepts are plausibly presented. The present writer once regarded Bronfenbrenner's procedure for scoring individual social status as promising (4), and Loomis and Pepinsky found "important" his method of testing the significance of individual scores (8, p. 262). Actually, a variety of misconceptions characterize both the Bronfenbrenner treatment of individual social status and his treatment of group structural aspects such as cleavage. But so subtle has been the misuse of well-known concepts and so elegant the mathematical language employed that it is most difficult to trace out the substructure of reasoning supporting the conceptual framework.

The present paper attempts therefore to separate out some of the flaws which weaken the constant frame and will suggest the sort of method that may prove more appropriate. It is realized that no statement in statistical theory can be definitive and that any current group measurement techniques are only a crude beginning in a new and rapidly developing field. In such a field, controversy among writers and frequent change of opinion is to be expected. But the problems here discussed seem particularly necessary to

[1] For valuable statistical advice rendered throughout the preparation of this article the author is indebted to Mr. Frank Gross, research statistician, Bureau of Naval Personnel.

[2] The opinions and assertions in this paper are those of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

re-examine since they represent a general orientation of research method which, if followed, might result in waste of effort on irrelevant problems.

Statistical comparability of scores. In his first article Bronfenbrenner states that "among the principal obstacles to more fruitful utilization of the sociometric method are certain technical inadequacies" requiring the development of "more refined techniques . . . for describing and comparing relationships in diverse sociometric situations" and for testing statistical significance (2, pp. 4, 6). The first of these problems is of course that of developing sociometric scores which will be statistically comparable from one group to another. Thus raw scores such as number of choices received or number of choices given out should be given a form having the same mathematical meaning, regardless of the size and dispersion and sometimes also the shape of the raw score distribution.

Bronfenbrenner's most fundamental difficulty appears at the outset in his misunderstanding of the reason why current psychometric scoring methods consider the total N, the standard deviation, and sometimes the skewness and kurtosis of the experimentally obtained raw score distribution. He thinks such procedures are a disadvantage because the meaning of the resulting scores "varies from distribution to distribution", and also varies according to "each sociometric setting" or "frame of reference" (2, pp. 7, 8).

The first half of the preceding statement is untrue, since customary use of distribution characteristics serves the purpose of freeing scores from diverse meanings and unequal weighting according to distribution, so that they can be mathematically compared or combined. Standard discussions such as those of Adkins (1) or McNemar (9) can be referred to on this point.

The second half of the quoted statement is true but does not represent a condition to be eliminated by comparable scoring, since the preservation of this condition, namely, the different meaning of a score in different frames of reference,[3] is one of the reasons for such procedures. Raw scores must be translated into mathematically common terms so that they will be free of irrelevant differences and their relation to group structure or some criterion of social behavior will be unequivocally revealed. For example, a sociometric percentile score of 30 may in one type of closely organized work

[3] *Frame of reference* here refers to the choice criterion, such as, "with whom do you want to be in the same study group?" For extensive consideration of the importance of the choice criterion, see J. L. Moreno, *Who Shall Survive?* Beacon House, 1st ed., 1934, 2nd ed., in press.

group indicate a higher production record than does a percentile of 30 in a loosely organized work group. This is the sort of difference that statistically comparable scores can bring out. Indices that did not have a different meaning in different experimental settings would obscure the experimental results obtained and it will be shown that this is what Bronfenbrenner's suggested scoring method does.

It is the above mentioned curious reversals of meaning regarding standard measures that lead Bronfenbrenner to his research for an "absolute" criterion, "an archetype unsullied by human preference or prejudice" (2, p. 9).

Individual deviation and distribution deviation from chance. In order to develop sociometric scores which will be comparable from group to group Bronfenbrenner proposes as an index of social status the likelihood that a given raw score would occur by chance. He thus suggests that an expression of statistical significance be used as a score. This fallacy will be discussed under a later heading, since it is irrelevant as yet. No valid test of significance was achieved by the method proposed in this section of Bronfenbrenner's paper.

The sociometric technique is frequently applied by asking each member of a group to choose a designated number of other members under some criterion such as "with whom would you like to study?". One problem is then to give standard expression to the raw choice score or number of choices received by each individual. Repeating the previous reasoning presented by Moreno and Jennings and in Lazarsfeld's formulas (12, p. 350), Bronfenbrenner correctly describes the group's chance distribution of choice as in their illustration following a binomial expansion. He then proposes to use this expansion for determining the probability of chance occurrence of each raw score, and to call the probability an "index of social status". To save computing the binomial terms a Type III curve approximation to the binomial is used. Each raw score is expressed as a deviation from the chance mean in terms of the chance standard deviation. The corresponding probability value is then read from a table of the areas of a Type III curve of the sme skewness as the binomial distribution employed.

It is not made clear how the probabilities would be translated into practical scoring form or how such standardization would apply to raw scores having no corresponding chance distribution, e.g., number of choices that an individual makes when he is allowed to make as many as he pleases. These difficulties are, however, not the basic error of the procedure.

In Bronfenbrenner's view, the chief value of his probability scores is

that they differentiate significantly overchosen and significantly underchosen individuals. He feels that "the fact that in sociometric tests persons are chosen so few or so many times as to yield statistically significant results points to the conclusion that factors other than chance must account for extreme positive and negative deviations in sociometric status (2, p. 41). Thus persons in the tails of the distribution are chosen not by "fortuitous circumstances" but by "socially determined behavior" (2, p. 31).

If it were true that most of the individuals in a group sociometrically tested were designated at random and only the highly overchosen and underchosen were selected through significantly socially determined behavior, then the sociometric technique could well be abandoned. Fortunately, this discouraging interpretation of score deviation from chance is based on a misconception of the nature of significance tests.

The significance test which Bronfenbrenner is concerned with is that of "goodness of fit" in which an entire obtained distribution is compared interval by interval with the relevant chance distribution. The deviation of obtained from predicted cell frequencies is evaluated as a whole and the conclusion may then be justified that this deviation of the entire distribution form from the chance distribution form is large enough to have occurred very infrequently by chance. The obtained and chance values compared are frequencies. Thus the fact that one specified sociometric choice score would happen infrequently by chance is not in itself significant; the important fact is whether the frequency of this score and the frequencies of all other obtained scores deviate from those predicted by chance.

To take an extreme example, imagine an experimentally obtained distribution which did occur entirely by chance and therefore followed the relevant binomial expansion. Such a distribution would of course contain in chance frequency individuals highly deviant from the mean. Their positions would be entirely fortuitous, yet in Bronfenbrenner's scoring they would be considered significantly overchosen or underchosen. In the ordinary sociometric situation of individuals not choosing by chance, probability scoring such as Bronfenbrenner proposes is indeed free of obtained dispersion and skewness, because it throws away experimental results and expresses scores in terms of a distribution which never occurred.

We may conclude that these "significant" scores are useless and that there is no justification for Bronfenbrenner's modification of Northway's target diagram by separating off probability intervals (2, p. 40). The essential distinction to remember here is that statistical significance in a "goodness of fit" problem does not refer to deviation from chance of an

individual value as such; it refers to frequencies of these values and to all the frequencies of which a distribution is made. Raw sociometric scores expressed in terms of their sigma deviation from the chance mean, simply become standard scores related to the mean and sigma of a non-existent distribution instead of to those of their own distribution.

We may be thankful then that Bronfenbrenner's original assumption of the inapplicability of percentiles and standard scores based on obtained distributions was incorrect. There is no reason why percentiles and standard scores should not be used for expressing sociometric individual raw scores such as number of choices received, number of choices given out, number of reciprocations achieved, etc., until something better can be developed. From these beginnings much superior methods of scoring can probably be devised, especially in regard to pattern scores more intimately related to group structure.

In connection with standard scores it may be noted that sociometric distributions are sometimes significantly skewed and that this fact has been a source of difficulty to experimenters who feel that distributions departing from the normal are somehow unnatural or hard to deal with. Such distributions are as a matter of fact not uncommon or strange in mental measurement and they do not necessarily require normalizing. If, however, the latter procedure seems desirable, it can be accomplished.

Ordinary standard scores will of course have the same skewness as the original raw score distribution. But standard scores normally distributed can be obtained by first expressing the raw scores as percentiles, then translating these into normally distributed standard scores by reference to a table of areas of the normal curve. Thus a percentile of 84 represents a normal curve area of 34 percent above the mean corresponding to a distance of about +1.00 sigma on the baseline. Such a percentile would be assigned the normalized standard score of +1.00. Note that this type of score is not a significance value and does not refer to the theoretical or chance distribution of raw scores. The procedure is described in more detail by Adkins (1, p. 143) and McNemar (9, p. 38).

Evaluation of the deviation from chance. Under this heading we will consider a number of Bronfenbrenner's procedures which fall in the category of significance tests.

Brief mention should first be made of a formula for the probability of occurrence of a given number of "isolates" (unchosen persons), since this formula was presented without derivation (2, p. 25) and has proved a puzzle. It has been pointed out briefly by Criswell (4), and in more detail

by Edwards (7, p. 377) that the formula resists derivation. It also does not yield a chance probability value comparable to that produced when the number of isolated and non-isolated is estimated from the binomial and tested by chi square. In correspondence with Criswell, Bronfenbrenner indicated inability to reproduce the original derivation. It therefore appears that the formula reflects some unidentified error. As a matter of fact, if isolates are important to the experimenter, the obtained frequencies of isolates and of non-isolates can be compared with the chance distribution as determined by the binomial, using the chi-square test. (See reference 12, p. 350, for the use of the binomial in predicting number of isolates.)

Perhaps more interesting than the testing of isolate frequencies is the determination of the deviation from chance of the frequency of mutual relationships (i.e., A chooses B and B chooses A) and of non-mutual relationships. For this purpose Bronfenbrenner quotes Lazarsfeld's formula for predicting the chance number of pairs (for this formula see references 2, 6, 12) and develops a new prediction formula for the frequency of pairs occurring under several criteria of choice applied to the same group. The latter formula which attempts to take into account cross-criterial relationships (A chooses B under criterion 1 and is chosen by B under criterion 2) is not particularly effective and a substitute has been offered by Criswell (6).

Bronfenbrenner then uses the binomial expansion to predict the chance distribution of mutual pairs. In this case, however, the application is irrelevant, as has been pointed out by both Criswell (4, 6) and Edwards (7). The binomial series refers to the distribution of a unitary independent event having two possible outcomes with probabilities of occurrence, p (probability of occurrence) and q (probability of non-occurrence). Thus it obviously does not apply to the distribution of the mutual pair which is a compound event requiring the coincidence of the two events "A chooses B" and "B chooses A". Since the chance distribution of mutual pairs is unknown, Bronfenbrenner's use of the binomial in testing significance is inapplicable. The chi-square test in this case of an unknown chance distribution is probably as accurate as any other. In actuality, the distribution of mutuals is likely to depart so grossly from chance that a significance test becomes a formality.

One caution in regard to the application of chi-square to the distribution of mutual and non-mutual relationships is that the test is not applicable to numbers of reciprocated and unreciprocated *choices*. The choices must all be considered in pairs because the two halves of a pair are not indepen-

dent events. Nonreciprocated as well as reciprocated choices have to be paired for the test because the occurrence of one nonreciprocated choice implies the existence of another.

For example, suppose that a group makes 20 reciprocated and 10 unreciprocated choices with corresponding theoretical values of 12 and 18. The numbers of pairs would be half as great: 10 obtained mutual, 5 obtained non-mutual, 6 chance mutual, 9 chance non-mutual. The deviation from chance would be 4. The chi-square expression would then be:

$$\chi^2 = \frac{(4)^2}{6} + \frac{(4)^2}{9} = 4.44$$

Although in the writer's experience the mutuality deviation from chance has tended to be great and the significance test almost superfluous, in group cleavage measurement the significance test is sometimes the only means of certainly determining that subgroups reject or prefer each other. In this type of experiment a certain group is known to be composed of different categories such as boys and girls, or Negroes and whites. The problem is to determine whether individuals make significantly more or significantly fewer choices into their own group than into others.

For predicting in-group and out-group choice in such a situation Bronfenbrenner presents the same probability formulas earlier stated by Criswell (3, 5). He then proposes a test for the significance of the deviation of obtained choice from expectation so that he can score the deviation according to the number of times it would occur by chance.

The discussion of the proposed significance test is quite interesting and contains considerable work on approximation to the binomial distribution by means of the normal curve and other methods. Unfortunately, however, the desired degree of accuracy in significance testing does not at present appear feasible. The binomial method suggested might be a sufficient approximation, but it is not as accurate as its proponent thinks.

As in treating individual scores the method proposed is to express the obtained deviation from the chance mean in terms of the standard deviation of the corresponding chance distribution and then to determine the number of times such a deviation or a larger one would have occurred fortuitously. In this case the method is appropriate to testing significance, because it relates obtained choice *frequencies* to theoretical ones. As before, the method approximates the chance distribution by treating it as a Type III curve of the same skewness as the expansion, and the desired chance probability values are read from a table of areas under the Type III

curves. For full details reference should be made to Bronfenbrenner's publication.

The reason why this method does not provide the accuracy aimed at is that the distribution of in-group and out-group choices made by a given subgroup does not follow the expansion of a binomial. Edwards is right in pointing out that the expansion is a multinomial in which the probability elements, p_0, p_1, etc., are the terms in a hypergeometric series and the multinomial exponent is the number of individuals in the choosing subgroup. The terms of the hypergeometric series in question express the probabilities that any subgroup A member making d choices will choose from subgroup B: no individuals, 1 individual, 2, 3, and so on up to d. The multinomial then combines the individual hypergeometric series and provides for subgroup A, containing A individuals and making a total of Ad choices, the probabilities of giving to subgroup B: 1, 2, and so on up to Ad choices.

A simple numerical example may make this clear. Suppose that we have a group of 5 individuals, 3 boys and 2 girls, making 2 choices each. We wish to predict how the boys' six choices would be distributed by chance to the two sex groups. As each boy chooses, his successive choices are made into a group reduced in size and changed in percentage composition by the withdrawal of his choices, since he cannot choose the same person twice. Thus the probability of choosing boys or girls changes as individuals are chosen and withdrawn from circulation. This is drawing without replacement and it results in a hypergeometric, not a binomial, series. The latter assumes replacement of drawings, with consequent unchanging probabilities on successive choices.

For any individual boy in our example, the probability that he will select a boy on the first draw is 2 in 4, since there are 2 boys in the group of 4 he is choosing into. If he chooses a boy first, his chance of choosing another boy in the second round is reduced to 1 in 3. Similarly, his chance of choosing first a boy and then a girl is $\left(\frac{2}{4}\right)\left(\frac{2}{3}\right)$; a girl first and a boy second, again $\left(\frac{2}{4}\right)\left(\frac{2}{3}\right)$. His chance of choosing 2 girls in succession is $\left(\frac{2}{4}\right)\left(\frac{1}{3}\right) = \frac{1}{6}$. Thus the terms of his hypergeometric series or that of any other boy are $p_0 = \frac{1}{6}$ (2 boys), $p_1 = \frac{4}{6}$ (a boy and a girl), $p_2 = \frac{1}{6}$ (2 girls). The total is of course 1.00. The corresponding

binomial, *inapplicable here,* is $p_0 = \left(\frac{2}{4}\right)^2 = \frac{1}{4}$ (2 boys), $p_1 = 2\left(\frac{2}{4}\right)\left(\frac{2}{4}\right) = \frac{2}{4}$ (a boy and a girl), $p_2 = \left(\frac{2}{4}\right)^2 = \frac{1}{4}$ (2 girls). The means of these two series are the same. If n = the number of choices (2 in this case), and p = the probability of choosing a boy $\left(\frac{2}{4}\right)$, each series yields a mean of np = 1 expected choice for boys. Three boys together would then give 3 choices to boys, 3 to girls.

After the individual hypergeometric series are obtained for a persons making a total of r choices, the series are combined by the multinomial $= (p_0 + p_1\chi + p_2\chi^2 + \ldots . p_r\chi^r)^a$ or in this case $\left(\frac{1}{6} + \frac{4}{6}\chi + \frac{1}{6}\chi^2\right)^3$. The coefficient of χ^r is the probability that the boys' group will make r choices of girls. To expand, multiply the expression by itself a—1 times and collect terms in the same power. The sum of terms in χ^4 will give, for example, the probability of 4 choices going to girls. The expanded expression will give the following probabilities:

Choices to boys	*Choices to girls*	*P*
6	0	$\frac{1}{216}$
5	1	$\frac{12}{216}$
4	2	$\frac{51}{216}$
3	3	$\frac{88}{216}$
2	4	$\frac{51}{216}$
1	0	$\frac{12}{216}$
0	6	$\frac{1}{216}$

From the above figures it can be determined that of the total number of choices given out by boys half will go by chance to girls and half to boys,

in this illustrative case 3 out of 6 to boys and 3 out of 6 to girls. This is the same chance distribution yielded by the hypergeometric series or the corresponding binomial. Thus we see that the three series do not differ in their prediction of the chance distribution. For a group of N persons with subgroups of A and B members making d choices per member, the expected numbers of choices directed from group A to group B and from group A to itself are then respectively: $\left(\frac{B}{N-1}\right)$ (Ad) and $\left(\frac{A-1}{N-1}\right)$ (Ad). In our example of boys choosing, the values would be: $\left(\frac{2}{4}\right)\left(6\right) = 3$ and $\left(\frac{2}{4}\right)\left(6\right) = 3$. These are very simple expressions previously presented in more detail by both Criswell (3, 5) and Bronfenbrenner (2). The matter is discussed here because Edwards in her otherwise able treatment of the expansions indicated that the required multinomial would not produce these formulas. The latter hold also for populations containing more than two subgroups. For discussion of the various probability series see such statistical texts as Smith and Duncan (12).

Although the three series we have considered predict the same mean number of choices given by group A to group B, they do not produce the same distribution forms around this mean. Therefore, to apply as strict a significance test as Bronfenbrenner aims at, the experimenter will have to develop the requisite multinomial and determine the standard deviation and skewness of the distribution around the expected value. The Type III curve of suitable skewness could then be entered with the obtained deviation expressed in terms of the chance standard deviation.

Incidentally, it should be noted here that Bronfenbrenner reads only one tail of the relevant Type III curve and thus produces P values only about half the size of those produced by chi-square applied to the same data. This error evidently stems from his thought that the significance value is itself a score and should therefore be characterized by the direction of its deviation from the mean. In this particular test of significance, however, the direction of the deviation can no more be predicted by chance than can its size. As a result, the deviation on both sides of the mean must be considered and P summed from both tails of the curve.

Another precaution is that, although Bronfenbrenner can throw together all choice criteria in applying his binomial, use of a multinomial would for greatest simplicity require making separate significance tests of

the distributions occurring under each criterion such as "with whom would you like to sit?", "which ones would you like to study with?".

More experimentation with chance distributions of choice would be interesting. When d, the number of choices per individual, is sufficiently small compared with N—1, the group chosen into, the hypergeometric series will approximate the binomial. In this case Bronfenbrenner's assumption of the binomial would hold reasonably well and his significance test could be used.

Ordinarily, it will probably be found that chi-square is a good enough significance test for sociometric distributions. Compared to Bronfenbrenner's method, the chi-square test is obviously less laborious and less complicated mathematically. It also does not require access to tables which are likely to be lacking in most psychological laboratories. Another advantage of chi-square is its additive character: values for N groups may be summed to give a total value with N—1 degrees of freedom. This value may be significant even though the component ones are not. The final advantage of chi-square will occur to anyone who tries to apply Bronfenbrenner's method to a population containing three or more subgroups and discovers the relative difficulties involved by the two significance tests.

One difficulty of chi-square's application to sociometric data is that, because of the small p's and N's frequently used, some of the cell frequencies for a particular group may fall below 5. In this case Yates' correction is helpful. Or it may in some cases be justifiable to combine for testing certain groups that are comparable in nature. Good discussions of chi-square, its restrictions, Yates' correction, etc., can be found in McNemar (9) and Smith and Duncan (12).

Skilled mathematicians, however, may be interested in experimenting with the applications of Bronfenbrenner's type of significance test to distributions in which cell entries are less than 5 or 10. In these cases, the results would theoretically be more accurate than a chi-square application.

Test of significance as scoring procedure. Our last consideration arises from Bronfenbrenner's consistent assumption that a significance test and a scoring method are the same thing. Thus he says that, "it will be evident from the very nature of the deviation-from-expectancy concept that it not only provides a constant frame of reference but that it may at the same time serve as an index of statistical significance" (2, p. 10). Here again, we have a reversal of the meaning of comparable scores and tests of significance. As in all comparable scoring, Bronfenbrenner's aim is to get away from purely mathematical elements that make scores different, and

arrive at a common meaning independent of the total number in the test score distribution, the dispersion of the distribution, etc. In order to do this he discards scoring methods which have some measure of success in eliminating these influences and embraces significance tests which are intended in their very nature to relate to sample size and to chance distribution instead of to the actual distribution of the variable studied.

Because of its relation to sample size, any score based on a significance test will automatically rise with size of group. Yet size of group and size of the various subgroups within it are a prime factor which sociometric scoring attempts to eliminate so that any experimentally obtained differences between groups of different size and composition can show up. The present author has been accused of regarding chi-square as a score (9, p. 275), but such an impression is erroneous since her method of scoring described in the original monograph (3) and given later in the present paper was developed because tests of significance as scores were regarded as inappropriate.

Although none of Bronfenbrenner's probability procedures yield statistically comparable scores, his rationale is perpetuated by Edwards' article which attempts to refine and simplify his constant frame. Edwards provides a very helpful critical evaluation of his work; some of her comments have already been referred to. The substitute formulas that she offers are also superior mathematically to the ones he presents. Her defect is one of omission rather than commission in that she does not question the necessity of the "constant frame of reference" as originally set up. Thus she assumes that Bronfenbrenner's difficulties are characteristic of sociometric analyses and proposes to simplify the matter by abandoning typically sociometric choosing techniques for a rating procedure in which each group member records for every other a reaction of "like", "neutral", or "dislike".

This method avoids some of the constant frame's difficulties by providing separate significance tests for each individual, since for each person independently the chance distribution of "like" and not "like" ratings would be as 1 is to 2. The obtained distribution of "like" and not "like" could then be compared independently with the chance values. Edwards seems to intend this as an improvement over Bronfenbrenner's scoring of individual social status. Consequently, the probability values for each individual's distribution must still be regarded as scores.

Such treatment of ratings provides a good illustration of the effect of sample size on probability scoring. For example, an individual obtaining 47% "likes" out of his total ratings from others, would in a group of 16

achieve such a deviation from chance approximately 30 times in 100 (7 "likes" obtained, 5 expected, $\chi^2 = 1.07$, $P = .30$). But in a group of 31 he would achieve 47% "likes" 13 times in 100 (14 "likes" obtained, 10 expected, $\chi^2 = 2.40$, $P = .13$). The group N would thus be bound up in the "score" which in the constant frame is P, the probability of chance occurrence of a certain deviation.

The same general comment applies to Edwards' treatment of mutual pairs, cleavage, and isolates. The mathematical technique seems adequate, but the basic rationale remains faulty. The expressions derived are indefensible as scores. If taken as tests of significance only, they are not complete, since they represent a reading from only one tail instead of both tails of the Type III curve.

A major aim of her treatment is to reduce what she believes to be the practical difficulties of sociometric analyses. Most of these difficulties were, however, specific to Bronfenbrenner's methods and can, as we have noted, be simply corrected by using genuinely comparable scores, and chi-square tests. We have seen also that the prediction formulas for in-group and out-group choice are simple, not complicated as Edwards claims.

The Bronfenbrenner-Edwards confusion about scoring can be the more misleading in that it may seem to refer to a different use of chance in relation to score, which at least at present appears legitimate. The weakness of the Bronfenbrenner methodology is not that it uses chance for the production of statistically comparable scores, but that it misuses the concept for this purpose. Some scoring problems can be solved by relating the obtained to the chance distribution in such a way that experimental data is not sacrificed or turned into a significance test. When groups vary in size and percentage composition, the chance structure differs so that obtained structure has a different statistical meaning from group to group. In order to equate for this shifting reference base, the entire obtained distributions for the various groups can be expressed in terms of their corresponding expected distributions. This method is not necessarily universally applicable or expressible in only one form, but it has been of assistance in determining in-group preference and can be applied to integration as measured by number of mutual pairs. It relates to structure of a group or subgroup as a whole, not to individual social status which, as we have seen, can be otherwise handled for comparable scoring.

The writer has previously stated the above mentioned scoring procedure too often for any detailed repetition here (3, 5, 6). Merely to illustrate the concept of a chance distribution as a base for measurement, let

us consider boys making 18 choices into a group which for each boy is composed of 8 boys and 4 girls, with each individual making two choices. The chance distribution of in-group and out-group choice is then 12 choices to boys and 6 to girls. This distribution is used as a base to which is related the obtained distribution of, for example, 16 choices to boys and 2 choices to girls. One method of doing this is to divide the obtained in-group to out-group ratio, 16/2, by the chance ratio, 12/6. The resulting group self-preference score for boys is 4.00, i.e., their preference for themselves is 4 times as great as chance would predict. Thus is derived a score independent of group size and percentage composition, and this was what we set out to do.

The preceding discussion has attempted not only to point out fallacies in proposed methods of sociometric scoring but also to indicate briefly alternative methods which can be found in the psychometric and mathematical literature. It should be noted that the later recommended methods are in general less complex and difficult than those advocated by Bronfenbrenner and Edwards. We may conclude then that statistical simplification does not dictate the scrapping of characteristic sociometric techniques of analysis but their extension to cover configurational dynamics, as early indicated to be essential by Moreno, Jennings, Lazarsfeld, and the writer. Upon examining the statistical bases of Moreno-Jennings' reasoning which led to Lazarsfeld's formulas, the writer finds substantiated the premises assumed by them.

Summary

The constancy of the frame of reference developed by Bronfenbrenner and refined by Edwards was investigated. The following misconceptions in regard to probability theory were thus detected and discussed:

1. Misunderstanding of the use of obtained N, sigma, and distribution form in producing statistically comparable scores.
2. Confusion of a score's statistical meaning with its meaning in relation to its experimental setting.
3. Assignment of separate statistical significance to a single value's deviation from the chance mean in a "goodness of fit" problem.
4. Use of an index of statistical significance as a score.
5. Miscellaneous errors in predicting distributions of mutual pairs, isolates, and in-group versus out-group choice.

The following remedial measures were recommended:

1. Use of percentile, standard, normalized standard, or any other scores that appropriately free scores of characteristics of the obtained distribution.

2. Use of the chi-square method as test of significance.

3. Possible use of a multinomial expansion instead of a binomial expansion in Bronfenbrenner's significance test.

4. Use of the appropriate chance distribution as a reference base for developing a score expressing a structural aspect of the group as a whole, e.g., in-group preference.

References

1. Adkins, D. C. Construction and analysis of achievement tests. U. S. Government Printing Office, Washington, D. C., 1947.
2. Bronfenbrenner, U. The measurement of sociometric status, structure, and development. *Sociometry Monographs,* No. 6, Beacon House, New York City, 1945. First published in SOCIOMETRY, Vol. 6, No. 4, 1943 and Vol. 7, Nos. 1 and 3, 1944.
3. Criswell, J. H. A sociometric study of race cleavage in the classroom. *Archives of Psychology,* 33, No. 235, 1939.
4. Criswell, J. H. "Foundations of Sociometric Measurements," SOCIOMETRY, IX: 7-13, February 1946.
5. Criswell, J. H. "Sociometric Methods of Measuring Group Preferences." SOCIOMETRY, VI:398-408, November 1943.
6. Criswell, J. H. "Measurement of Group Integration." SOCIOMETRY, X:259-267, August 1947.
7. Edwards, D. S. "The Constant Frame of Reference Problem in Sociometry." SOCIOMETRY, XI:372-379, November 1948.
8. Loomis, C. P., and Pepinsky, H. B. "Sociometry 1937-1947: Theory and Methods." SOCIOMETRY, IX:262-286, August 1948.
9. McNemar, Q. *Psychological Statistics.* John Wiley and Sons, Inc., 1949.
10. Moreno, J. L. Who Shall Survive? 1st ed., 1934, 2nd ed., in press, Beacon House, Inc.
11. Moreno, J. L., and Jennings, H. H. Statistics of Social Configurations, SOCIOMETRY, 1938, I:342-374, Jan.-Apr. 1938. Also published in *Sociometry Monographs,* No. 3, Beacon House, Inc.
12. Smith, J. G., and Duncan, A. J. *Sampling Statistics and Applications,* McGraw-Hill Book Co., 1945.

PUNCHED CARD TECHNIQUE FOR THE ANALYSIS OF MULTIPLE LEVEL SOCIOMETRIC DATA

LEO KATZ
Michigan State College

INTRODUCTION

In the collection and analysis of sociometric data, there are apparently conflicting desiderata. On the one hand, we are usually not satisfied to attempt to decipher the structure of a group on the basis of only one aspect of choice relationships.[1] For example, answers to the question "Which members of your group would you like to have share your table at meals?" leave undetermined such important elements as prestige, sources of information, etc. We should prefer to ask and obtain responses to a variety of such questions, each bearing upon a facet of the group structure and providing *in toto* a complete summary of that structure. The particular set of questions used in any one group will depend on the group and also upon the intent and point of view of the experimenter. Thus, the domain of sociometric analysis, except in the cases of analyses conducted on a very trivial basis or for extremely special purposes, is necessarily on several levels or in several dimensions. From the psychological standpoint, we should consider it extremely unlikely that any but the most primitive groups are structured in one dimension only. This means, then, that we must explore not only the linear structures with respect to each aspect being considered but also the relationships or interactions between them. For example, again, we are not only interested in the cleavages of a group with respect to choice of dining-table partners and whatever else is implied by these choices; there

---

[1] *Editorial Note:* Dr. Katz's statement is true. But from the point of view of the immediate situation, it is perfectly satisfactory if only one aspect of choice relationships is explored first; indeed it would be confusing to the participants to be exposed to more "research" than necessary.

On the other hand, if total guidance of the community is what the members want, then a cluster of criteria for choice is mandatory because there is a cluster of immediate situations. It should be kept in mind, however, that if a community is interested to work on one pattern of its networks only (*i.e.*, the patterning in respect to one criterion of associating only), that is its members' right. They can later decide what next, and what next, and so on. (See footnote 2.)

Securing choice data regarding one criterion nevertheless discloses important elements in respect to that one network. Even with the use of many criteria, "completeness" is but approximated.

are also important cleavages on moral grounds, intellectual grounds, etc.[2] Our ultimate concern is to measure *all* of the pertinent cleavages *and* to determine the extent to which the various cleavages interact. The typical raw data we must collect to answer questions such as these are the responses of each individual in the group to each other[3] one on each of a set of test items.

This brings us, then, to the other side of the dilemma. Life is short. We do not care to spend a few years on a complete analysis of a group which was probably selected originally for study because it was readily available and our personal relationships were such that we could make the necessary arrangements. Our typical set of data collected in a group of N individuals who were asked to respond to n items consists of $nN(N—1)$ items arranged in a three way $n \times N \times N$ matrix with the main diagonal of each $N \times N$ submatrix (corresponding to self-choices) vacant. The mass of data, itself, is formidable. It is the author's opinion that it is at this point that investigation and experimentation in the technique and analysis will

---

[2] *Editorial Note:* While this statement is certainly correct, it is also true that cleavages on moral or intellectual grounds are important only *insofar as they result in cleavages in sociometric structure.* Upon this basic premise, the significance of the sociometric approach rests. Through sociometric tests also, for example, the precise avenues of what situations or activities are marked by cleavage between people of differing ideologies can be delineated. People interact in role-relationships and every role-relationship contains intellectual, moral and cultural, as well as psychological, facets; the choice process operates within (and cannot operate outside of) such context, whether on the criterion of dining-table partners or whatnot. But, as Dr. Katz points out, the latter criterion (dining-partners) cannot reveal the extent to which some other criteria may be involved in cleavages related to moral or intellectual considerations on the part of members of a given population, nor how various cleavages interact. (J.L.M.)

In J. L. Moreno, *Who Shall Survive?* (1934) are treated many of the theoretical and practical problems pertinent to *what is a pertinent cleavage.*

[3] *Editorial Note:* It is, of course, not necessary that each individual in the group give some sort of response to *each other* person in the group. To require this forces the chooser to align his choices to fit given categories set up by the experimenter and is also not necessary to the author's experiment. Instead, wherever individuals do not rank all others in the group, such lack of response towards others (unranked) can be coded and represented in some way or left blank according to the objectives of the sociometric test. The importance to research which the scheme of analysis presented by Dr. Katz offers us would in no way be lessened thereby; it will be noted that it does not hinge upon getting a response by each member towards all others. And by not requiring "indifferent" reactions (or those below the subject's threshold of noting) to be given a rank other than no reaction, we would avoid regimenting the data so as to affect their validity. (J.L.M.)

be most fruitful. Formulation of the problem in terms of matrices and adoption of the procedures of matrix algebra in some degree are necessary to make the situation at all manageable. With these conventions, the many different automatic and semi-automatic computing devices now available may be used to handle the computations provided the data are so set up that they may be programmed into one of these devices. The more complicated of these computers are not ordinarily accessible, as yet, to researchers in the social sciences; for this reason, there is presented in this paper a scheme for setting up such data in a form particularly suited to analysis by standard tabulating machines. There will first be described, in some detail, the suggested procedures for collecting the data and recording them on punched cards. The remainder of the paper will discuss typical problems arising in the analysis and the techniques of programming the necessary computations into the tabulating equipment. Each operation is designed to use the simplest, most generally available equipment possible. It is assumed that the reader is familiar with basic punched card technique as contained in the IBM manual [5].

Collection and Recording of Data

Collection. It is useful procedure to present to each individual a complete list of the members of the group before asking him to make his choices.[4] This is to insure against any individual's being overlooked in making a set

[4] *Editorial Note:* It is important that a comparative study should be made to find out how choice expression is affected under the condition of complete listing as against no listing of names of members eligible for choice. This would appear needed because at present we do not know precisely what difference either method makes to the chooser's performance.

In the apparent effort to give everyone an equal opportunity to be chosen through having his name on a list in front of the chooser, it may conceivably, for example, happen that in some cases the chooser warms up to names when he would not otherwise have had the individuals in mind. Or, as J. L. Moreno has pointed out, we may use a research method which "coerces democracy." (See, J. L. Moreno, "Sociometry and Marxism," Sociometry, XII: 106-143, Feb.-Aug., 1949.) In administering sociometric tests, the procedure has to aim to accommodate to a maximum degree the chooser and not the investigator (whenever this cannot be done simultaneously), in order that choice expression be fully spontaneous. Considerations bearing upon this point are also mentioned in footnote 4. It will be noted there that Dr. Katz's major contribution in this paper is equally applicable to choice data secured without a listing of names or use of numbers by the subject himself. It should be stressed, also, that we should not skip the step of investigating in what ways, if any, choice expression varies *with manner of* administering sociometric tests. (J.L.M.)

of choices. This omission might occur in several ways; for example, psychological rejection of an individual might be so pronounced that he is not even considered for *rejection* as a dining-table partner. Occurrences of this kind are fairly effectively precluded by forced scanning of a complete list. The list can be made to serve other purposes as well. This can be done if each name on the list is preceded by a serial number and the members of the group being tested are asked to respond with the numbers rather than the names. Immediate advantages are that it is easier to write a two- or three-digit number than a three- to ten-letter name and that the possibility of confusing a James H. with a James P. is removed. If it is considered an advantage to give complete freedom regarding the number of choices expressed, the factor of fatigue operates in a negative manner. Since less effort is required to write half a dozen numbers than to write two or three names, it is more likely that people asked to respond by numbers will give more complete statements than those who respond by name.[5] In certain groups where the motivation is not very great, this feature may be rather important. A less obvious advantage, however, which derives from the use of numbers is that responses are precoded by the respondent for direct transfer to the punched cards.

The collected data consist, then, of the responses, a set of numbers, of each of N individuals to each of n test items. The items occasionally will be both aspects of a single question as, for example, "Which people would you like to be your dining-table partners?" and "Which people would you prefer *not* to share your dining-table?" At any rate, for our present purpose, we shall consider such two-sided questions to constitute two distinct test items.

Recording the data. For economy and for ease in programming computations, it will be expedient to use one punched card to represent a whole vector, that is, a row of choices in the $n \times N \times N$ matrix. Considering the manner in which the data were collected, it will probably be simplest to punch on a single card the responses of one individual to every other member[6] of the group on one test item. This will result in a preliminary deck (Deck A) consisting of $n \times N$ cards.

---

[5] *Editorial Note:* Although logically this might seem so, psychologically it may turn out not to be so. The use of numbers may be found to interfere with *the warming up process to the act of choosing* as we all think of one another not in terms of numbers but of names. It may be suggested that whatever may possibly reduce the subjective element of the chooser himself should be investigated, and "economies" avoided if these are found significantly to affect the chooser's involvement in the expression of his choices.

[6] See footnote 3.

In a typical investigation it will be necessary to reserve the last ten or fifteen or twenty columns of an eighty column card for identification and classification according to whatever criteria are considered important. To make the situation concrete, suppose that we require twenty columns. We should then set aside columns 61 to 80, inclusive, and assign the serial numbers corresponding to the first 60 columns to the members of the group. If there are over 60 in the group, we would find it necessary to use two or more cards to represent an individual's responses to the whole group. In this event, we would use numbers 101 to 160, 201 to 260, etc., and identify the card sequence by an appropriate punch. The number of cards in Deck A would then be multiplied by the largest integer in $\frac{N+59}{60}$.

The actual punching of cards would proceed as follows:

1. In each column corresponding to a number mentioned in response to item #1, punch a "1". This stage will be facilitated by insertion of tabular stops at convenient points.
2. In column 61, punch a "1".
3. In columns 62-80, punch group identification (if more groups than one are involved in the study), serial number of the respondent and social, economic, ethnic, etc. classifications as coded.
4. Repeat as in (1.) punching "2" corresponding to responses in item #2.
5. In column 61, punch a "2".
6. Duplicate from previous card columns 62-80.

7.ff. Repeat steps 4 to 6 with responses to item #3, #4, etc.

This process, for each respondent, gives a set of n cards or, with N respondents, a total of $n \times N$ cards.

This method of recording data represents two major departures from the procedure advocated by Beum and Criswell [1]. In the first place, instead of a single response, each card represents a vector of N responses. Secondly, each card contains background information for the respondent only, the respondee being designated only by a columnar position on the card. These two changes produce greater economy in processing and collating the data at the expense of somewhat less flexibility. We must judge the method, then, in terms of the relative losses and gains. We shall first show that the loss in flexibility is not irreparable and that a fairly simple device serves to give flexibility equal to the Beum-Criswell technique. The prime advantage of using a card to represent each single choice is in the duality achieved, i.e., a card may be interpreted as "A *chooses* B" or as "B is *chosen by* A". Beum and Criswell suggest construction of a second

deck from the first by transposition of the respondent and respondee fields to exhibit this effect more clearly.

The procedure analogous to the above transposition in the present method is to construct a second deck (Deck B) of cards which represent vectors of choices coming *in* to each individual. If a tabulator is available, this may be simply done as follows:

1. Split Deck A into subdecks A_1, A_2, etc. according as choices are given for items #1, #2, etc., respectively. This is done by sorting on column 61.
2. Arrange each subdeck in serial order. Efficient routine would involve doing step 2 first, then step 1. The arrangement as given here is to indicate schematically, rather than practically, the procedure.
3. For each subdeck, print across the tabulator sheet, the serial number and all of the columns 1-60 taking care to suppress zeros. This printing gives the complete $N \times N$ matrix of choices on one test item, the rows representing the vectors of outgoing choices as punched in Deck A and the columns, the vectors of incoming choices.
4. Punch into the first 60 columns of Deck B cards consecutively the columns of the printed matrix. The field of columns 61-80 may be entered by duplication from the A deck or by reproduction before or after punching the field 1-60. If columns 61-80 are entered after field 1-60, it is only necessary to punch the serial number into the appropriate columns of the B deck at the time the first 60 columns are punched. The B deck should be identified by an X-punch someplace in the classification field.

Note. If the group consists of 30 or fewer individuals, it will be expedient to punch the B information into the unused field of columns 31-60 of the A deck. Thus, each individual's card will show in column 1 whether he chooses the first member of the group and, in column 31, whether the first member chooses him. The collation of incoming and outgoing choices is useful for discovering mutual choices but even more important is its utility in facilitating the computations required by the method of analysis proposed by Luce and Perry [10]. More will be said of this later.

Once a B deck of cards has been made up as outlined above, everything possible by the Beum-Criswell technique is equally possible in this system with the added advantages that machine runs are shorter and that several operations may be combined in a single run.

A third deck of cards may be useful in certain cases. This can be constructed from the A deck as follows:

1. Arrange the A deck in serial order and separate into subdecks as in steps 1 and 2 of the procedure for constructing the B deck. (It

may be desirable to construct both the B and the C decks simultaneously, if both are needed.)

2. Reproduce the A_1 deck.

3. Into the reproduced deck, gang-punch the A_2 deck, the A_3 deck, etc.

4. Verify by sighting through column 61 that each subdeck, A_1, A_2, A_3, etc., has been punched into the one deck of N cards.

5. This deck is the C deck and should be identified by a convenient X-punch in the classification field.

The deck of cards so constructed summarizes the information of the A deck into fewer cards with the information more completely collated. Each card now represents an $n \times N$ submatrix of the complete choice matrix (provided n is not greater than twelve). A card is interpreted as giving all the responses of one individual to every test item. There are, of course, exactly N cards in this deck.

Limitations of the method and extensions. The restrictions on the method are largely those due to physical limitations of the punched cards and the tabulating machinery. As indicated previously, the limitation to groups of 60 is easily removed by using two or more cards to represent a single vector. This is cumbersome, but it is true that any method of handling groups of that size is likely to be cumbersome. If a group only slightly exceeds 60 in number, serious thought should be given to an attempt to get the whole vector on a single card. The ultimate in this direction is to provide space for 78 choices with only two columns reserved for identification and the classification material punched into a separate deck of cards with the same serial identification numbers. This device may be entirely satisfactory for certain investigations.

Another restriction on the method is that ordinary tabulating equipment can distinguish between the presence and absence of only twelve distinct punches, so that we are restricted to twelve test items in general. However, if the group consists of no more than 43 members, it is possible on an alphabetical tabulator to distinguish between presence and absence of each of 12 numerical symbols and 24 alphabetical symbols, a total of 36. (Zero and one exclude the letters "O" and "I".) This implies that, in studying large groups, we are limited to 12 test items without special arrangement while, with small groups, up to 36 test items are possible. This is not too severely restrictive, since our investigations of smaller groups are ordinarily more detailed than our investigations of large ones.

Computational Procedures

Choices made and received. Once cards have been prepared, it is very simple to obtain complete counts of the numbers of choices made and received by each member of the group on each test item. On a tabulator, using the A and B decks sorted according to column 61, we simply record the totals of punches in each column, with the tabulator controlled on column 61, and finally divide these totals by the numerical symbols in that column. An alternative procedure is to work with a counting sorter and the C deck, which represents a summary of the A cards, or the A cards themselves. If the C deck is used, counts may be checked by a second run with the deck reversed. Here one run is required for each individual. Counting on the first column results in a set of totals representing the number of choices *received* by the first individual on each of the test items. This operation is repeated $(N-1)$ times to obtain similar totals for the other members of the group. The whole operation is then repeated with the B deck, or a summary deck reproduced from that deck, to obtain the totals of choices *made* by each member of the group.

Mutual choices. In considering mutual or reciprocated choices, we may require two different kinds of information. Both are easily obtained from the punched cards. If we wish to identify the mutual choices, we may do this fairly efficiently by superposing pairs of corresponding cards from the A and B decks and sighting through each pair. An alternative device, developed by Lehmer and Elder [9], involves placing the pair of cards in the duplicating rack of a duplicating key punch and obtaining a third card showing only the common punches. Each column in the field 1-60 which exhibits paired punches represents a mutual choice between the individuals corresponding to that column and to the pair of cards. If we wish only to count the numbers of mutual choices involving each member of the group, the counting may be handled mechanically as a special case of a more general procedure which will be described in a later section on powers of the matrix.

Cleavages. The measurement of cleavages in a group is facilitated by use of the C deck of cards, since cleavage with respect to all of the test items may be evaluated simultaneously on a counting sorter. On a tabulator, the A deck (or the B deck) would be used. Cleavage is usually measured in terms of an index contrasting the relative numbers of choices out of the possible choices going to the ingroups and the outgroups. In order to construct such an index, we require for each of the m subgroups into which the entire group is classified, the number of choices going to

each subgroup and the number of individuals in the group. As the problem has been set up here, we need this information for each of n test items. Essentially, this means that we break up the total matrix of response into $m \times m$ submatrices. Breaking up the total matrix in this way reduces the problem of measuring cleavage to one of counting choices as in the preceding paragraph, except that we are not interested in column totals but only in the grand totals for each submatrix.

Translated into operations, this means that, on the counting sorter, we do not record the totals in a column but accumulate the totals by *not clearing* the counters until we have run all the columns corresponding to a subgroup. On the tabulator, the physical breaking up of the matrix is accomplished by wiring together into adjacent counters the columns corresponding to members of one subgroup and by sorting the deck by the criterion classification as well as by column 61, with subsequent minor and major controls on the two sorts. If m, the number of subgroups, is large, the amount of card-handling at the sorter will become excessive and use of the tabulator will be indicated. In most applications, however, m will be 2 or occasionally 3 and so will represent no serious problem.

A whole new field of systematic research in group cleavage is opened by use of punch card methods, viz., what is the nature of the interdependences of ethnic cleavages with economic status cleavages, social status cleavages, etc.? To what extent does cleavage in one area carry over to determine or affect cleavage in another? The C deck of cards should be very useful in such investigations since it serves to collate choices in different areas. An alternative process in the investigation of these phenomena involves disregarding cleavage and studying instead overall interdependences of *choices*. In this process, a factor analysis of the correlation matrix of choices on the several levels might be useful. The application of these punched cards to obtaining the correlation matrix is discussed in a later paragraph.

Analysis using powers of the matrix of choices. An elegant method of analysis of group structure proposed by Luce and Perry [10] depends upon examination of powers of the matrix of sociometric choices, where choices are restricted to be positive only and equally weighted. In their scheme, each choice is conceived to be a unidirectional link from person a to person b. The original choice matrix contains all the information concerning the links. In the intersection of a's row and b's column we find the number (0 or 1) of choices, or 1-chains, going from a to b. If the matrix is squared, i.e., is multiplied by itself according to the formal rules of multiplication

of matrix algebra, the element at the intersection of a's row and b's column is an integer giving the number of 2-chains connecting a to b. A 2-chain is defined to be the sequence of relations, "a chooses c; c chooses b." Obviously, a 2-chain connecting a to a (a chooses b; b chooses a) is a mutual choice. Such mutual choices appear only in the principal diagonal of the squared matrix and each mutual choice appears twice, once in each of the principal diagonal positions corresponding to the pair of individuals making the reciprocal choices. Thus, the trace of the squared matrix (sum of the principal diagonal terms) is twice the number of mutual choices in the group. Each element in the third power of the matrix gives the number of 3-chains running from one member of the group to another, e.g. "a chooses b; b chooses c; c chooses d." On the main diagonal, each appearing in three different places, are the closed chains of length 3, i.e., "a chooses b; b chooses c; c chooses a." Similar statements may be made for fourth and higher powers.

In private conversations of the author with Perry and with Festinger who has described applications [3] of the method of Luce and Perry, it was indicated that two rather serious problems remained to be solved before their analysis could be considered complete. One of these is the computational problem of efficiently obtaining the matrices corresponding to the powers of the original matrix; the second is the more technical problem of handling the so-called "redundancies" in the n-chains which arise to plague the experimenter. The first of these problems can be solved fairly completely by use of the A and B decks of cards described above.

Consider that we have asked each member of a group to indicate with which other members he would like to be associated in some one activity. The data are punched into an A_1 deck of cards, corresponding to a matrix A of elements a_{ij}, where $a_{ij} = 1$ if the ith member chooses the jth member of the group and $a_{ij} = 0$ otherwise. We wish to determine the matrix $S = A^2$, with elements s_{ij}. The formal rule for matric multiplication gives the following relationship between the elements of the two matrices:

$$s_{ij} = \sum_{k=1}^{N} a_{ik}\, a_{kj}.$$

Verbally, this means we must multiply together the kth element of the ith row and the kth element of the jth column of the matrix of choices, and then add together the N products for $k = 1$, $k = 2$, . . . , $k = N$. But, the kth element of the ith row, a_{ik}, appears in the ith column on the kth card of the B_1 deck and the element a_{kj} appears in the jth column of the

kth card of the A_1 deck. Therefore, we may obtain the sums, s_{ij}, through card-by-card multiplication of column i in the B_1 deck by column j of the A_1 deck. Further, on a tabulator or multiplier, it is possible to obtain several (perhaps N) of the s_{ij} simultaneously. The process, using a tabulator, is as follows:

1. With both decks in serial order, sort on column i of the B_1 deck.
2. Select by hand or by mechanical collation the part of the A_1 deck corresponding to those cards in the B_1 deck punched "1" in column i.
3. Run this part of the A_1 deck through the tabulator, counting in each column. The totals should be printed and summary-punched into a new card. The total printed for column 1 and summary-punched into column 1 (or columns 1 and 2) of the summary card is the element s_{i1} of the squared matrix S. The other totals are $s_{i2}, s_{i3}, \ldots s_{iN}$, respectively. This summary card is then a representation of the ith row vector of the S matrix.
4. The process is repeated for $i = 1, i = 2, \ldots, i = N$.

Note: It was indicated in a previous section that if N is small enough ($N \leqslant 39$), it is possible to punch both the A_1 and B_1 fields into a single card. In this case, the kth elements of rows and columns are already collated and step 2 above may be eliminated.

The process is carried on to produce higher powers by replacing the A_1 deck in the above procedure by the $S=A^2$ deck of cards to produce in exactly the same way the A^3 deck. The A^3 deck is then used to produce the A^4 deck, etc.

Use of a multiplier of the high-speed type (IBM type 602 or 604) recently developed by IBM would make possible the elimination of the sorting (step 1) in the procedure above. It is not possible to say at this writing which procedure would be best. Some experimental work is now being done under the auspices of the Social Research Service at Michigan State College and will be reported on shortly.

Structure of a group as indicated by clique formation. Two alternative procedures have been proposed for the study of clique structure. One is the Luce and Perry method described above; the other was discussed in a pair of papers the first by Forsyth and the author [4] and the second by the author alone [7]. In this latter procedure the matrix is rearranged by simultaneous reordering of the rows and the corresponding columns to produce more compact distribution of positive choices about the principal diagonal. A criterion has been proposed to accomplish this effect. We define the distance of an element in the ith row and jth column from the principal

diagonal to be i—j, i.e., the magnitude, without regard to algebraic sign, of the difference between i and j. A sort of canonical form of the matrix for our purposes is then defined to correspond to that permutation of the rows and columns which minimizes the sum (or the sum of squares) of the distances of all the elements weighted by the numerical values of the responses. The responses are taken to be zero for indifference and positive and negative integers for acceptance and rejection. If there are more than one degree of acceptance (or rejection), appropriate integers are used.

In choosing between the two methods for analysis of clique structure, the nature of the data available will probably play a decisive role. The Luce-Perry method uses only equally weighted positive choices but is more direct and is automatic in operation. The Forsyth-Katz technique, since it permits using both choice and rejection at more than one level each, is capable of somewhat sharper delineation of the cliques. Also, cliques have status in the group just as individuals do. It is, therefore, desirable to exhibit the *interclique* structure as well as the *intraclique* structure. This, too, is possible by the latter method.

Formal operations with punched cards to produce the rearrangements required by the Forsyth-Katz procedure are summarized below. We shall assume, to make the illustration concrete, that we have asked each member of the group with which members he would like to work (+1), which of those he would most like to work if it were not possible to get all in the same work-group (+2), which he would prefer not to work (—1), which he should most strongly object to working (—2), and which it is a matter of indifference (0). He must place every member of the group in one of these five categories.

1. Punch into a set of cards like the C deck mentioned previously the information obtained, using "1" for the least desirable category, "2" for the next, etc. This deck differs from the C deck in that there must be exactly one punch in each column except for the column representing self-choice.
2. Three alternative systems are available for identification, according to the size of the group studied. If $N \leqslant 25$, individuals may be identified by a letter punched in the self-choice column. (Do not use "I" or "O", an "X" numerical punch is available.) If $N \leqslant 40$, a two-column field may be used for each individual and a two-digit serial number punched in the self-choice field. (It is advisable to use serial numbers 11-50.) If $N \leqslant 78$, an "X" numerical punch is inserted in the self-choice column and the serial number is punched in the last two columns of the card.
3. The deck is sorted in serial order and the original matrix is printed on the tabulator.

4. By inspection, some preliminary grouping and rearrangement of the ordering is made. This should be done by reordering manually the deck of cards. This reordering is duplicated in the wiring to the printing bars of the tabulator.

5. A second matrix derived from the reordering of step 4 is printed on the tabulator. If the ordering of rows and columns have been properly synchronized, the identification symbols will appear in the principal diagonal; this serves as a check on the work.

6. Repeat steps 4 and 5 to improve the matrix.

7. etc. The process is iterated until the matrix is in satisfactory form.

It is immediately evident in step 4 that a subjective element is present and that good judgment will aid in the rapidity of convergence of the process. This subjective judgment will be materially improved if an analysis of the Luce-Perry type is done first on the positive choices only with all positive choices taken to have equal weight.[7]

Correlational analysis. As soon as we ask why people make the choices that we observe, two kinds of problems present themselves. First we ask, "Why do members of a group chose other members to work with? Is the selection on social grounds, or ethnic, or economic, or psychological?" Then, since we are not naive enough to believe that choices are based on only one factor, we seek to determine the relative importance of each factor. Finally, our sophistication increasing by leaps and bounds, we seek information on the changing importance of factors in different kinds of groups under differing conditions, etc. The second sort of problem which arises is in answer to questions like "Are work-partners chosen on the same bases as play-partners? To what extent are the bases of choice different? How different are they in different types of groups?"

Both problems may be expected to yield to modes of investigation borrowed from psychometrics. The obvious technique to be used is that of factor analysis of an appropriate matrix of correlation coefficients. The notions involved are enunciated in more complete detail in a paper [8] on the factor analysis of sociometric data which will appear shortly. Our concern here is with the process of obtaining the appropriate correlation matrices.

If our concern is with the factors underlying the choices expressed by

[7] Since this paper was written, two alternative methods of ordering the sociomatrix have been developed. One is presented by Corlin O. Beum and Everett G. Brundage, "A Method for Analyzing the Sociomatrix," elsewhere in this issue. The other, by Leon Festinger, has not yet been published.

the members of a group, we must study the similarities in patterns of choices as represented by the matrix of correlations between the choices expressed by each pair of individuals. There are, in all, $\frac{N(N-1)}{2}$ such pairs. This problem exhibits complete duality, i.e., any factor which is important in determining the choices *made* will be equally important in determining the choices received. We may, therefore, use either the A deck or the B deck of cards in the investigation. If multiple levels of choice and rejection are involved, the cards are prepared as explained in the first two steps of the preceding section. The technique of obtaining simultaneously the sums necessary for computation of a complete matrix of correlation coefficients on a tabulator is well-known [8]. It is only necessary to identify r_{ij} as the correlation between the data in columns i and j of the B deck, say.

If we are interested in the correlations between choices made in pairs of areas or according to pairs of criteria, the situation is made a little more complex because of the several different kinds of combinations of variables we may encounter. For this reason, no general technique will be given for this situation. It will be necessary, in general, to make a choice between tabulator runs as above and accumulation on a sorter as described in the section on cleavages. In no case will the mechanical process be unduly involved.

Note on recent machine developments. Throughout this paper, stress has been placed on the use of existing, readily available, tabulating equipment. However, two machines have recently been introduced which make possible large savings in time through their greater capacity. The IBM 407 tabulator has 120 alphabetic type bars instead of the 43 on the older machines and prints at 150 lines per minute. The IBM 101 statistical machine counts in 60 positions anywhere on the card in place of the 12 positions in a single column handled by the older equipment.

Summary

As we progress beyond the surface of sociometric investigations, it becomes evident that we must take into account information on many aspects on many levels of interpersonal relationships. This immediately poses the problem of handling the masses of data. It is suggested that the data may be made tractable by representing on a single punched card an entire vector or an entire rectangular array of such data, that is, an entire row of the sociomatrix. Examples are given of the application of such cards to various kinds of sociometric computations, some of which have not been previously made because of the excessive amounts of time required.

References

1. C. O. Beum and J. H. Criswell, "Application of machine tabulation methods to sociometric data", Sociometry, X: 227-232, August, 1947.
2. C. O. Beum and E. G. Brundage, "A Method for Analyzing the Sociomatrix," Sociometry, XIII: May, 1950.
3. L. Festinger, "The analysis of sociograms using matrix algebra," *Human Relations,* II: 153-158, 1949.
4. E. Forsyth and L. Katz, "A matrix approach to the analysis of sociometric data: preliminary report", Sociometry, IX: 340-347, November, 1946.
5. *IBM Electric Punched Card Accounting Machines,* International Business Machine Corporation, Endicott, N. Y.
6. L. Katz, "On the matric analysis of sociometric data", Sociometry, X: 233-241, August, 1947.
7. L. Katz, "Factor analysis as a tool of sociometric research", to be published.
8. Lehmer and Elder, *Factor Stencils,* Carnegie Institution of Washington (1939).
9. R. D. Luce and A. D. Perry, "A method of matrix analysis of group structure", *Psychometrika,* XIV: 94-116, 1949.
10. R. M. Mendenhall and R. Warren, "The Mendenhall-Warren-Hollerith correlation method", *Columbia University Statistical Bureau Document,* No. 1 (1929).
11. J. L. Moreno, *Who Shall Survive?* Beacon House, 1st ed., 1934, 2nd ed. in press.
12. J. L. Moreno, "Sociometry and Marxism," Sociometry, XII: 106-143, Feb.-Aug., 1949.

POPULATION/DISTANCE AND MIGRATION FROM KENTUCKY

FRED L. STRODTBECK
Yale University

Introduction.

In the February-May 1948 issue of this journal there appeared an article, "Demographic Gravitation", (3) which proposed that the social scientist should give greater attention to the study of population/distance potentials. It was suggested that the generalization of the social phenomena associated with these potentials would probably reveal relations which are now obscured by the person-oriented bias of most sociological research. In line with this suggestion we propose to test the appropriateness of p/d for describing one migration situation. This particular investigation has been designed to provide a comparative test of p/d and two alternative theories.

The Test Situation.

We shall consider the Kentucky-born persons who were resident in 1930 in cities of population over 50,000 within 650 miles of the periphery of Kentucky. We have shown (6, pp. 18-24) that these migrants are highly homogeneous, the majority of them having migrated from the Appalachian foot-hill counties of Kentucky in 1920-30 to work as industrial laborers in the 128 cities of the sample. The restriction to 650 miles from the periphery of Kentucky enables us to avoid inclusion of any substantial area outside continental United States.

There are three principal theories which we shall test:

I The number of migrants decreases as the distance increases (2).

II The number of persons migrating to a given location is proportional to the number of persons already at the location and is inversely proportional to the intervening distance (2).

III The number of persons migrating to a given location is proportional to the opportunities at the location and inversely proportional to the intervening opportunities (5).

These theories, the first two by Ravenstein and the third by Stouffer, may be quantitatively represented. Let y equal the number of migrants expected; D equal distance; P equal population; x equal intervening opportunities; Δx equal opportunities at the location; and k equal a constant employed to adjust the sum of the theoretical expectations to the sum of the migrants observed. The above theories may then be written:

$$\text{I} \qquad y = k_1 \frac{1}{D}$$

$$\text{II} \qquad y = k_2 \frac{P}{D}$$

$$\text{III} \qquad y = k_3 \frac{\Delta x}{x}$$

TABLE 1

NUMBER OF MIGRANTS PREDICTED BY THE INVERSE DISTANCE FORMULATION.

Mean Distance from State	Reciprocal of Distance	Expected (in 00's)
D	$\frac{1}{D}$	$k_1 \frac{1}{D}$
12	.08333	1563
62	.01613	303
87	.01149	216
112	.00893	168
162	.00617	116
187	.00535	100
212	.00472	89
237	.00422	79
262	.00382	72
287	.00348	65
312	.00321	60
337	.00297	56
362	.00276	52
387	.00258	48
412	.00243	46
437	.00229	43
462	.00216	41
487	.00205	38
512	.00195	37
537	.00186	35
562	.00178	33
587	.00170	32
612	.00163	31
637	.00157	29
——	.17858	3352*

* Differs from 3350 due to rounding.

For test of these theories the cities of the samples have been grouped by 25-mile distance intervals. Distance is computed by first class, hard surface road from the periphery of Kentucky. No city over 50,000 occurs in the second and sixth interval, hence values are given for only 24 cases. For the purpose of testing III, the number of persons living within a city who were born outside the state in which the city is located is assumed to be proportional to the number of opportunities within the city (see reference 7 for a further discussion of this assumption). The details of computation are presented in tabular form; the necessary operations are described in column heads of Tables 1, 2, and 3.

TABLE 2

NUMBER OF MIGRANTS PREDICTED BY THE POPULATION/DISTANCE FORMULATION.

Mean Distance from State D	Population (in 000's) P	Ratio $\frac{P}{D}$	Expected (in 00's) $k_2 \frac{P}{D}$
12	681	56.75	1276
62	321	5.18	116
87	69	.79	18
112	871	7.77	175
162	1131	6.98	157
187	50	.27	6
212	410	1.93	43
237	1581	6.67	150
262	2354	8.98	202
287	5156	17.95	404
312	396	1.27	29
337	314	.93	21
362	299	.83	19
387	746	1.93	43
412	705	1.71	38
437	573	1.31	29
462	386	.84	19
487	1057	2.17	49
512	1263	2.47	56
537	570	1.06	24
562	2652	4.72	106
587	607	1.03	23
612	866	1.42	32
637	8942	14.04	316
—	—	149.00	3351*

* Differs from 3350 due to rounding.

TABLE 3

NUMBER OF MIGRANTS PREDICTED BY THE INTERVENING OPPORTUNITY FORMULATION.

25 Mile Intervals Numbered From State	Persons Born Outside of State (in 000's) In Band Δx	Intervening x	Ratio $\frac{\Delta x}{x}$	Expected (in 00's) $K\frac{\Delta x}{x}$
1	254	127	2.00	1,132
2	0	254	.00	0
3	130	319	.41	232
4	15	392	.04	23
5	350	574	.61	345
6	0	749	.00	0
7	430	964	.45	255
8	21	1,189	.02	11
9	146	1,273	.11	62
10	705	1,698	.42	238
11	1,187	2,645	.45	255
12	2,259	4,368	.52	294
13	142	5,568	.02	11
14	150	5,714	.03	17
15	69	5,824	.01	6
16	244	5,980	.04	23
17	287	6,246	.05	28
18	186	6,482	.03	17
19	128	6,639	.02	11
20	526	6,966	.08	45
21	381	7,419	.05	28
22	93	7,656	.01	6
23	907	8,157	.11	62
24	268	8,744	.03	17
25	409	9,082	.05	28
26	4,104	11,339	.36	204
Total	13,391	——	5.92	3,350

The values of the constants k_1, k_2 and k_3 are determined as follows:

$$k_1 = (3350/.17858) = 18,759.1$$
$$k_2 = (3350/149.00) = 22.5$$
$$k_3 = (3350/5.92\ ) = 565.9$$

The comparison between the number of migrants predicted by each of the three theories under consideration and the number of migrants observed is given in Table 4. At the bottom of Table 4 are presented the rank

TABLE 4

NUMBER OF MIGRANTS PREDICTED BY ALTERNATE THEORIES AND OBSERVED.

Distance Band	Theory I	Theory II	Theory III	Observed
1	1563	1276	1132	896
2	—*	—	—	—
3	303	116	232	228
4	216	18	23	21
4	168	175	345	483
6	—*	—	—	—
7	116	157	255	187
8	100	6	11	6
9	89	43	62	61
10	79	150	238	168
11	72	202	255	382
12	65	404	294	407
13	60	29	11	36
14	56	21	17	13
15	52	19	6	12
16	48	43	23	11
17	46	38	28	69
18	43	29	17	10
19	41	19	11	14
20	38	49	45	75
21	37	56	28	19
22	35	24	6	15
23	33	106	62	28
24	32	23	17	7
25	31	32	28	92
26	29	316	204	105
ρ	.40	.87	.91	——
χ^2	5487	1377	638	——

* Values are predicted by I for the 2nd and 6th interval. These values have been suppressed to liberalize the test of this theory which is not sensitive to discontinuities in the data. This shortcoming does not apply to II and III.

order correlations (ρ) between each theoretical series and the observed frequencies. Concerning the rank order correlations, they are quite high for case II and III. In terms of chi-square, one would require a value of less than 42 in order to retain the null hypothesis of no significant difference between the observed and expected at the .05 level. It is quite apparent that all three formulations greatly exceed this criterion value. Ranked in terms of the acceptability of the fit, the order is III, II, and I.

One is not warranted in saying that either formulation II or III are superior to one another on the basis of these tests; however, they appear to provide a considerably more satisfactory fit than formulation I.

Discussion.

Moreno, in writing of II and III above, has made the interesting comment (1, p. 127):

> The formulas of Stouffer and Stewart, based on statistical analysis of number and distance, even if correct in themselves, are unsatisfactory because of their symbolic character, leaving the people out, the dynamics of interpersonal and intergroup relations.

While we would have to discuss further the proposition that a formulation may be "unsatisfactory" even if "correct," we do agree heartily with the spirit of his comment which we interpret as a protest against reasoning with concepts without showing the way in which their referants are socially mediated.[1] We believe that the data we have presented above are particularly free of the difficulties which may be anticipated in general migration situations. For example, the area is uninterrupted by geographical barriers and there are no national or ethnic barriers for the migrants in question. Our guess is that if there were barriers of these types operative, both formulations I and II would soon become encumbered with all sorts of limitations concerning "saturation" and "penetration" (4); "molecular mass" and "human gas" (3); and "curvature of the earth" (8, p. 57n). Even if it may be granted that some combination of the above "corrections" would fit many distributions in the same sense that a curve may be fitted through any number of points, it does not follow that such a fitting process would be of value to the sociologist.

In Stouffer's application of III to movement between census tracts in Cleveland, he found that his fit could be improved by taking into account the range of rental value of the houses in question. Later, he found differences in the nature of "opportunities" for Negroes in contrast to whites, and further differences between ethnic groups (5). The fact that he was able to improve his fit by such corrections has a certain "truth-likeness" for us in terms of our common experience. His theoretical model, which is

[1] See J. L. Moreno's formula of social gravitation, *Am. Soc. Rev.*, XII: 287-292, June 1947, "People 1 (P1) and People 2 (P2) move towards each other—between a locality X and a locality Y—in direct proportion to the amount of attraction given (a1) or received (a2), in inverse proportion to the amount of repulsion given (r1) or received (r2)." (Ed. Note)

built around the concept "opportunity", causes him to search for corrections in terms of the social perception of the migrants. Whatever mechanistic attribute Stouffer's formulation may take on derives not from a disregard of interpersonal and intergroup relations, but from the practical necessity of working with data less sensitive than the underlying postulated relationship would ideally require.[2]

In conclusion, the reader is reminded that the particular test presented in this paper does *not* provide an adequate basis for the appraisal of p/d in all of the contexts in which it may conceivably be used. The present application to migration from Kentucky shows that p/d gives a rough engineering approximation of the observed distribution—but significantly, an approximation which is not better than that provided by the alternative intervening opportunity formulation. While it may be possible to use population/distance to advantage as an approximation in situations where relatively little data are available, it has not been generally demonstrated that it is superior to intervening opportunities for the conceptualization of migration phenomena. The fact that neither of the principal theories we have considered provide a truly acceptable fit suggests that additional types of data must be incorporated into whatever formulation is eventually successful. Insofar as the intervening opportunity formulation provides a rationale for selective refinement in terms of socially mediated factors, it is, in the opinion of the writer, a more suitable vehicle for deductive investigation than population/distance.

---

[2] For a somewhat different comparison, Stouffer's intervening opportunity theory may be simpler than p/d insofar as the possible exponent of the denominator is concerned. This may be shown by writing II and III as follows:

$$\text{IIa} \qquad y = k \frac{P}{D^n}$$

$$\text{IIIa} \qquad y = k \frac{\Delta x}{x^n}$$

We may then solve for the value of n which will minimize the square of the deviations. For the data above, n for II is 2.21 and for III, n is .95. Stewart has shown that this n varies when migrants to a particular location are being considered and has suggested that this value may be used as a measure of the "penetration" of influence of a population at a distance (4). For our data, and for Stouffer's data, n is close to 1; so it is possible that the least square fit to determine n for IIIa will generally produce an n so close to 1 that no appreciable improvement will result if the calculations are corrected in this fashion. For our data, this correction changes chi-square from 638 to 557.

Bibliography

1. J. L. Moreno. "The Three Branches of Sociometry: A Postscript". Sociometry, XI:121-8, February-May, 1948.
2. E. G. Ravenstein. "The Laws of Migration". *J. Royal Statistical Society,* 48: 167-235, June 1885; 52:241-305, June 1889. Reviewed in Dorothy S. Thomas, *Research Memoranda on Migration Differentials,* Social Science Research Council Bulletin No. 43, New York, 1938.
3. John Q. Stewart. "Demographic Gravitation: Evidence and Applications". Sociometry, XI:31-57, February-May, 1948.
4. ———. "Measure of Influence of a Population at a Distance". Sociometry, V:63-71, February, 1942.
5. Samuel A. Stouffer. "Intervening Opportunities: A Theory Relating Mobility and Distance". *American Sociological Review,* V:845-867, December 1940.
6. Fred L. Strodtbeck. "Migration From Kentucky: A Study of Intervening Opportunities". Unpublished M.A. Thesis, Indiana University, 1942.
7. ———. "Equal Opportunity Intervals: A Contribution to the Method of Intervening Opportunity Analysis". *American Sociological Review,* XIV:490-497, August 1949.
8. G. K. Zipf. "The Unity of Nature, Least Action, and Natural Social Science". Sociometry, V:48-62, February 1942.
9. J. L. Moreno. "Contributions of Sociometry to Research Methodology in Sociology". *American Sociological Review,* XII:287-292, June 1947.
10. Paul H. Maucorps. *La Psychologie des Mouvement Sociales.* Presses Universitaires, Paris, 1950.

A SIMPLIFIED EXAMPLE OF THE USE OF MATRIX MULTIPLICATION FOR THE ANALYSIS OF SOCIOMETRIC DATA

JAMES CHABOT

Department of Psychology, University of Michigan

The sociometric technique as a tool in social psychology appears to have potential value which has not been realized in actual experimentation. The major difficulty has unquestionably been the lack of an adequate, systematic method of analysis of the wealth of data resulting from this simple procedure. Recently Festinger (1) with Luce and Perry (2) at the Massachusetts Institute of Technology has developed some promising matrix algebra methods for analysis of sociometric data. These procedures have proved useful in research problems and there is, no doubt, much more that can be gained by further development of the approach.

This paper is intended to be a relatively simple exposition of the method as it has been used in an industrial study. Little of the data and theory of the study is included here; material from the study that has been included is used for the purposes of illustration.

An office force of two hundred workers was being studied and because some of the workers were doing simple clerical work that was measured daily, it was possible to relate their production rates to their sociometric position in the groups. The most homogeneous group in terms of type of work and experience on the job consisted of thirteen girls who typed customer bills. These girls were members of a subgroup of twenty-five workers. The data reported here concern this subgroup. The sociometric data were obtained on a single question form administered to small groups. The number of choices was left unstructured and all choices were used in the study.

The girls were able to know roughly each others' production rates because they worked in close proximity and the material was distributed in boxes of constant quantity. In addition, they knew their own rates and could communicate these if they wished. We have reason to believe from interviews, however, that this was a topic that was suppressed because of social pressures.

One of the hypotheses developed was that the degree to which individuals were sociometrically connected to the group would be negatively correlated with their production rates. To state it simply, we developed this hypothesis because those who were high producers were making the competition stiff and consequently there would be social pressures to operate within a normal range. A failure to conform was a negative criterion

for choice, but, of course conforming was not a sufficient condition for choice.

One of the problems that arose in the study was a need to obtain some measure of the degree to which individuals in a production group were sociometrically connected to the group. It was apparent that some individuals were in good contact with many of the group while others were relatively isolated. But it was felt that the level of production at which these individuals operated had an effect on their sociometric position in the group.[1] We hypothesized that high production would tend to make individuals peripheral in the sociometric structure of this particular work group. The simple total of choices received in a sociometric test, is an obvious measure to use, but it was felt that such a measure ignores the differences between being accepted by central members and being accepted by peripheral members of the group. A measure that would give some weight to these differences was desired. The matrix method of analysis mentioned above offered a measure that appeared to approach a satisfactory measure of this sort of sociometric acceptance or degree of connectedness.

The data from one of the production groups in the study are presented in the matrix of Figure 1. The method of analysis of these data will be described before indicating the results of this part of the study.

The meaning of the matrix (Figure 1) can perhaps best be explained by illustration. The convention has been to represent the choices made by an individual in a row of the matrix and the choices received by an individual are represented in a column of the matrix. Thus, reading across Row 2 we find that Person 2 (P2) has chosen P6 and P20. Reading down Column 2, we find that P2 has been chosen by P6, P16, P20, and P22. The individuals are represented in the rows and columns in the same order, so that the cells of the major diagonal (upper left to lower right) represent the individual's reaction on the sociometric test; the individual cannot choose himself so that this cell is left blank. Each cell then represents one individual's reaction to another (a choice or no-choice). By entering the choices made in a sociometric test on a matrix, we have, of course, expressed all the choices received as well as made.

In this form, it is quite difficult to perceive relationships by inspection, but by squaring the matrix we can arrive at a pattern in matrix form that shows quite clearly how an individual is connected to others in the group

1 See J. L. Moreno, section on "Organization of Work Groups," in *Who Shall Survive?* 1st ed., 1934, 2nd ed., in press, Beacon House, pp. 108-113, 318-319.

FIGURE 1

FIGURE 1

P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1					(1)														1						
2						(1)														(1)					
3																		(1)					(1)		
4											(1)														
5	(1)										(1)														
6		(1)																		(1)					
7								1	(1)					(1)	1				1					(1)	(1)
8									(1)						1	1			(1)					(1)	
9							(1)	(1)							1				(1)						(1)
10									1						(1)				(1)						
11	1			(1)	(1)																				
12							1						(1)				(1)								
13												(1)					(1)								
14							(1)	1	1		1													1	(1)
15										(1)							1		(1)	(1)		(1)			
16		1																					(1)		
17							1					(1)	(1)												
18			(1)																					(1)	
19								(1)	(1)	(1)					(1)										(1)
20		(1)				(1)				1					(1)				1						
21																								1	
22		1														(1)									
23			(1)															(1)							(1)
24							(1)	(1)																(1)	
25							(1)	1	(1)					(1)	1				(1)						

MATRIX OF SOCIOMETRIC CHOICES
Mutual choices are in parens.

through those he chooses and through those who choose him. Speaking loosely, we can find how an individual is related to the group.

From the squared matrix we can identify the individual's position in relation to those chosen by him. Perhaps this can be best explained by explaining first the meaning of a single cell in our illustrative squared matrix. On Figure 2, the squared matrix, we find that cell $A_{2,6}$ (the cell of Row 2, Column 6) has a value of one. The value of one means that P2 has chosen

FIGURE 2

P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1										1														
2		2				1									1					1					
3			2															1					1		
4				1	1																				
5				1	2																				
6		1				2									1					1					
7							4	2	1					1					2					1	3
8							2	3	1	1					1				1						3
9							1	1	4	1				2	1				2					3	2
10								1	1	2					1				1	1					1
11	1										2														
12												2	1				1								
13												1	2				1								
14							1		2					2					1					2	1
15		1				1		1	1	1					3				1						1
16																1									
17												1	1				2								
18			1															2					1		
19							2	1	2	1				1	1				5	1				2	1
20		1				1				1									1	3					
21																					0				
22																						1			
23			1															1					2		
24							1		3					2					2					3	1
25							3	3	2	1				1	1				1					1	5

SQUARED MATRIX OF MUTUAL CHOICES

one individual who has chosen P6. In cell $A_{6,2}$ we also find a value of one. This means that P6 has chosen an individual who has chosen P2. From this it can be seen that the row for each individual on the squared matrix informs us with whom the individual is connected by two-choice paths. Following the terminology of Luce and Perry, paths will be referred to as n-chains where the n represents the number of sociometric links in the path. The cell tells us the direction of the choices as well as the individuals who are connected. For example, the unit value in cell $A_{2,6}$ tells us that the choices went from P2 to some other individual and then to P6. It will be noticed that we do not have only unit valued cells on the squared matrix.

Cells with values of more than one appear quite frequently and these values tell us the number of 2-chains by which two individuals are connected; or, saying it another way, it tells us the number of people who have been chosen by one individual who have also chosen the second individual. For example, if the cell $A_{2,6}$ had had a value of two, we would have known that P2 had chosen two individuals who had chosen P6. We can see, then, that the rows and columns begin to tell us how well connected to the group each individual is. The row and column for an individual can mean psychologically a wide variety of things; for a row represents the 2-chains an individual has with the group by virtue of the people he chooses, while the corresponding column represents the 2-chains with the group that he has by virtue of the choices he receives. If an individual chooses peripheral members, this obviously means something different than if he chooses central members of the group. We can get some indication of this phenomenon by comparing an individual's row with his column. If he chooses central members he will have a greater number of chains than if he chooses peripheral members, and the same statement holds for a column. Then, an individual who chooses central members and is chosen by peripheral members will have a relatively large number of chains in his row but few in his column, etc. It is not claimed that these definitions of "central" and "peripheral" are the only ones possible, but they were found useful in this study. Since this discussion is somewhat afield from our purpose, let us resume the investigation of the matrix proper.

Unlike the original matrix, the squared matrix does have values in the major diagonal cells and these are of particular interest. These values represent for the various individuals the number of mutual choices they have. This a 2-chain, but of course in this case is unique in that the individual is connected to himself by the 2-chain. This, obviously, means a path of the type "PA to PX to PA" or two individuals mutually choosing each other. Each path of this type for an individual adds one to the value of his major diagonal cell on the squared matrix, so that the total value of this cell is the number of mutual choices he has.

The preceding discussion applies equally to the squared matrices containing both reciprocated and unreciprocated choices, and to matrices limited to mutual choices. For this paper, only the mutual choices of Figure 1 were used in obtaining the squared matrix of Figure 2. This was done because, as will be discussed later, only mutual choices were used in the identification of cliques. When a matrix of mutual choices is squared, the resulting squared matrix is symmetrical. It is apparent that the original

matrix of mutual choices must also be symmetrical. If a matrix is symmetrical about the major diagonal, the corresponding rows and columns are identical. That is, Row 1 is the same as Column 1; Row 2 the same as Column 2, etc. The matrix of Figure 2 is symmetrical, and the matrix of Figure 1 is symmetrical if only the mutual choices are considered. The mutual choices on Figure 1 are in parentheses.

The process of squaring the matrix is a simple one. To obtain the value in a cell of the squared matrix, the row and column of the original matrix corresponding to the coordinates of the cell are multiplied. That is, cell A^2_{ij} is the product of Row i and Column j of the original matrix. The product of a row and a column is the sum of the products of the cells of the row and column taken in order. The first cell of Row i is multiplied by the first cell of Column j, the second cells are multiplied, the third, etc., and the sum of these products is then the value of the squared matrix cell A^2_{ij}. If we let the cells of Row i be represented by $A_{i1}, A_{i2}, \ldots . A_{in}$ and the cells of Column j be represented by $A_{1j}, A_{2j} \ldots . A_{nj}$, we can state the product A^2_{ij} algebraically as: $A^2_{ij} = A_{i1}A_{1j} + A_{i2}A_{2j} + A_{i3}A_{3j} \ldots . A_{in}A_{nj}$. In practice, this can be carried out without too much difficulty because of the large number of zeros in the cells. The matrix may also be cubed by multiplying the rows of the original matrix by the columns of the squared matrix (or the columns of the original matrix by the rows of the squared matrix). This we can state as: $A^3_{ij} = A_{i1}A^2_{1j} + A_{i2}A^2_{2j} + \ldots . A_{in}A^2_{nj}$.

The result of cubing the matrix is a matrix (see Figure 3) which gives the 3-chains that connect individuals in the group. The meaning of this matrix is similar to that of the squared matrix but for the fact that the connections are 3-chains. These paths are of the type "W to X to Y to Z"; a path of this type results in a unit value added to the cell A_{wz} of the cubed matrix. The values of the major diagonal cells of the cubed matrix are of particular interest and these will be discussed later.

The cubed matrix then gives us a further indication of the degree to which individuals are connected to the group. In the study the sums of the cubed matrix rows were used as measures of the individuals' degree of connection to the group. Correlating the production rates of individuals with

FIGURE 3

P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0			1	2																				
2		2				3				1					1				1	4					
3			2																				3		
4	1			0							2														
5	2				0						3														
6		3				2				1					1				1	4					
7							6	4	11	2				7	2				6					9	9
8							4	2	9	2				5	2				9	1				8	4
9							11	9	6	3				3	3				9	1				4	12
10		1				1	2	2	3	2				1	4				6	1				2	2
11				2	3						0														
12												2	3				3								
13												3	2				3								
14							7	5	3	1				2	1				3					2	8
15		1				1	2	2	3	4				1	2				7	5				2	2
16																0						1			
17												3	3				2								
18																		2					3		
19		1				1	6	9	9	6				3	7				6	1				4	12
20		4				4		1	1	1					5				1	2					1
21																					0				
22																						0			
23			3															3					2		
24							9	8	4	2				2	2				4					2	11
25							9	4	12	2				8	2				12	1				11	8

CUBED MATRIX OF MUTUAL CHOICES

their cubed matrix row totals (all choices being used for this cubed matrix) gave a product moment correlation of —.56 ($p < .05$).[2]

This negative correlation substantiated the hypotheses that the greater an individual's contact with the group, the lower would be her production rate.

Shortly after the sociometric test was given, the entire unit was moved to another building several miles from the original location. On the basis of evidence that the workers perceived this move as an arbitrary whim of management, we hypothesized that one of the indications of resistance would be a further emphasis on production rate as a negative criterion for choices of friends within the group. A second sociometric test was administered and the correlation of production rates and cubed matrix row totals was —.73 ($p < .01$). This, we felt, indicated an increased use of production level as a criterion for choices made on the sociometric test.

Another hypothesis that we had was that as a result of group-standards,

[2] Correlating the total number of choices received with production rate give a correlation of —.25 which was not significant.

subgroups within the group would have different levels of production. The problem here was to identify subgroups within the total unit. Having defined the sociometric characteristics of the subgroups in which we were interested, this could be done by following through the original data by inspection, but this would have been an extremely laborious project for sociometric data on two hundred individuals. The matrix method gives us a more convenient solution to this problem.

From the cubed matrix of mutual choices, we can identify groups who all mutually choose each other. These subgroups (of three or more) who all mutually choose each other will be called cliques. The major diagonal cells of the cubed matrix indicate which members of the groups are in cliques and which are not. For the purpose of identifying cliques, we use only mutual choices in squaring and cubing the matrix as we have done in the sample matrices shown here. The reasons for this will be explained below.

If the major diagonal cell of the cubed matrix for an individual has a value other than zero, he is a member of a clique; if his value in this cell is a zero he is not a member of a clique. In addition to identifying clique members and non-clique members, the values in the major diagonal cells also inform us of the number of members in the cliques. For the sake of explanation let us take a simple example from Figure 3, the cubed matrix of mutual choices. From this matrix we can see that P1 has a value of zero in the major diagonal cell so that she is a non-clique member. P2, however, has a value of two in her cell which means she is a clique member. Now this value of two means that P2 can reach herself by two different three-choice paths. There is only one kind of path that this could be, that is, a path of the type a to b to c to a. Because we have used only mutual choices, the path must be reversible, that is, a to c to b to a. From the above we can see that *a* would have a value of two in her cubed matrix major diagonal cell. This also shows us that *a* is a member of a clique of three—the other members being *b* and *c*. Thus, it can be seen that the diagonal cell value of two means that P2 is a member of one clique of three. To state the relationship of size of clique and value of the cell more generally, we can say that for a clique of size n, the cubed matrix major diagonal cell value for each member will be $(n - 1)(n - 2)$. For example, an individual in a clique of four members would have a diagonal cell value of six, i.e., $(4—1)(4—2) = 6$. Of course, we usually want to know more about a group member than the fact that he is or is not a clique member; we often want to know who the other members of the clique are. Another simple relation-

ship helps us in identifying the other clique members. Their cell values in the cubed matrix row of the member (e.g. P2) have a *minimum* value of $[(n-1)(n-2) + 1]$. For a clique of three members this value is three. Consequently for P2 we can see immediately that P6 and P20 are the other members of the clique. If an individual is a member of more than one clique, these relationships on the cubed matrix are not quite so simple, but by referring to the original matrix these cliques can be established. For example, if an individual is a member of two cliques with three members in each, his major diagonal cell value on the cubed matrix would be four. From his row on the cubed matrix, we could immediately identify which individuals were possible members of the cliques but it might be necessary to refer to the original matrix to define the exact relationships. Because of this, as a practical rule in using the system, it is usually best to eliminate the non-clique members, then establish the cliques where we find values of two in the diagonal cell, then for values of four, etc. By this method overlapping cliques can be more easily identified.

In the study, five cliques for which complete production data were available were identified. These five cliques fell into three different levels of production and the differences between cliques at the different levels were highly significant. After investigation of several possible explanations, we concluded that these cliques had formed standards on the level of production which they would maintain.

The matrix method analysis of sociometric data that has been described shows two distinct features that may be of value to research workers. The method results in a matrix that indicates the pattern of relationships between individuals who are two and three choices removed from each other. And the method also makes relatively easy the identification of mutually choosing subgroups.

More recently Luce has developed a method of identifying subgroups of individuals who are all n or fewer choices removed from each other.[3] The nature of the research problem will, in general, determine the characteristics of the subgroups that it would be desirable or feasible to work with.

[3] "To determine subgroups, called n-cliques (of three or more members), for which each member is connected by an n-chain or shorter chain to each other member, first compute the matrix powers A, A^2, A^3, . . . A^n. Then add these together: $B(n) = A + A^2 + A^3 + \ldots + A^n$. Now form a pseudostructure $B'(n)$ which has 0's were B(n) has 0's and 1's where B(n) has positive entries. Extract the mutual choices from $B'(n)$ *i.e.*, the symmetric part and compute the cliques of $B'(n)$ as if it were an ordinary sociometric matrix. The cliques of $B'(n)$ can be shown to be identical with the n-cliques of A." Quoted from an unpublished paper by Duncan Luce.

There are several other unsolved problems in the use of this matrix system. For example, negative choices and choices of values other than one (certainly all choices are not of the same "intensity") are problems yet to be attacked. It seems certain that many more methods useful in determining characteristics of sociometric matrices can be developed.

References

1. L. Festinger. "The analysis of sociograms using matrix algebra", *Human Relations*, II:153-158, 1949.
2. R. D. Luce and A. D. Perry. "A method of matrix analysis of group structure," *Psychometrika*, XIV:94-116, 1949.
3. J. L. Moreno, *Who Shall Survive?* 1st ed., 1934., 2nd ed., in press, Beacon House.

A METHOD FOR ANALYZING THE SOCIOMATRIX

CORLIN O. BEUM, JR., *Dunlap and Associates*

EVERETT G. BRUNDAGE,* *Bureau of Naval Personnel*

Introduction

The study of intergroup and intragroup relationships is a very fruitful and necessary occupation for persons who hope to understand more of the ways in which the "human animal" behaves in social situations.

Among the several schemes developed for the representation of group structure two leading ones are the sociogram (6) and the sociomatrix. The sociomatrix as described by Forsyth and Katz (3), Beum and Criswell (1), Festinger (2), and others is a device for representing in a systematic fashion the outgoing and incoming selections of the group under study, when the criterion of choice is some such question as "with whom would you rather eat lunch?"

In such a situation the members of the group indicate their choice of lunch companions by, let us say, writing the names of their first and second choices on a card along with their own name. These cards are then sorted by name or code number of chooser. The names (or symbols) are then copied onto a sheet of paper containing as many rows and columns as there are people in the group. The names are ordered identically in the rows and columns and the choices are entered as: first choice = 2, second choice = 1. Figure 1 shows a hypothetical sociomatrix for a group of 6 persons, each person represented by a letter.

Method

In Figure 1 the rows represent the outgoing or given choices and the columns represent the incoming or received choices.

FIGURE 1

	A	B	C	D	E	F
A	—		2			1
B		—		2	1	
C	1		—			2
D		2		—	1	
E		1		2	—	
F	1		2			—

ILLUSTRATIVE CHOICE MATRIX

* The opinions presented are those of the author and should not be regarded as having the endorsement of the Department of the Navy.

It is apparent from a small matrix such as the above that group structure can be determined by inspection as in the sociogram. So far the only difference from the sociogram has been to rewrite the data in a more systematic manner. But this systematization does not in itself reduce the labor of analysis. If the matrix were 20 by 20 or 50 by 50 instead of 6 by 6, determining the group structures would still be a lengthy task.

Festinger (2) has shown that if the weighting of choices is disregarded and the resulting matrix of 1's and zeros is squared the mutual pairs appear on the diagonal and are extracted quite readily. If the matrix is cubed, triads appear in certain ways, etc. Beum and Criswell (1) have demonstrated how the mutual pairs may be extracted by another process involving the use of punched card machines. Forsyth and Katz (3, 4) have shown that if, in a matrix such as given in Figure 1, the columns and rows are rearranged so as to maximize the unknown diagonal any group structure will appear as clusters along this diagonal.

The purpose of this paper is to present a method for systematically rearranging the columns and rows of such a matrix so as to maximize the unknown diagonals and thus reveal any subgroups or structures within the matrix. The method places no restrictions on the cell entries. They may be choices, ratings, rankings, percentages, or any measure of interpersonal relationship. The interpretation of the resulting structures may vary for each type of data used, but not the method of determining this structure. In the present illustration the system of weighting gives greatest weight to the first choice or highest rating and the principal diagonal is maximized. If weighting were reversed and first choice or rating received a value of 1, the principal diagonal would have to be minimized.

It can be shown that if weights are assigned to the rows of a sociomatrix (from 1 to N beginning with the bottom row) as indicated in Figure 2 and the average product of the elements in each column and the corresponding weights is maximized for each column, the sum of the squares of the elements about the principal diagonal is minimized.

The first steps in the process of maximizing the principal diagonal are shown in Figure 2 and explained below.

If an analysis of "received" choices is to be made the matrix is prepared as in Figures 1 and 2. If an analysis of "outgoing" choices is to be made the transpose of this matrix is used. In some situations the matrix will be symmetrical and the row sums will equal the column sums. In any case the procedure outlined below is to be used.

1. The elements of each column in turn are summed to obtain the column sums.

FIGURE 2

Weight		A	B	C	D	E	F	Sum
6	A	—		2			1	3
5	B		—		2	1		3
4	C	1		—			2	3
3	D		2		—	1		3
2	E		1		2	—		3
1	F	1		2			—	3
	Sum	2	3	4	4	2	3	18
Sum of Products		5	8	14	14	8	14	63
Average Weight		2.50	2.67	3.50	3.50	4.00	4.67	
Rank		6	5	4	3	2	1	

STEP 1 IN MAXIMIZING PRINCIPAL DIAGONAL

2. Weights of from 1 to N are assigned to the rows of the matrix, beginning with 1 as the weight of the bottom row.
3. The elements of each column in turn are multiplied by the weights and the weighted sums are obtained. (Diagonal elements are treated as zeros.)
4. The weighted sums are divided by the column sums to obtain the average weight.
5. These averages are ranked from 1 (for the largest) to N (for the smallest).
6. The matrix is then rearranged so that the column with the highest average (rank 1) is moved to the extreme left and the corresponding row is moved to the extreme top. The next ranking column is placed next and the corresponding row is placed in position 2 from the top, etc. Figure 3 shows the matrix after the rearrangement indicated in Figure 2, and the computations necessary for the next iteration. Note that the column and row sums remain the same in each rearrangement, and that the total of the "sums of products" is the same in each rearrangement.

FIGURE 3

Weight		F	E	D	C	B	A	Sum
6	F	—			2		1	3
5	E		—	2		1		3
4	D		1	—		2		3
3	C	2			—		1	3
2	B		1	2		—		3
1	A	1			2		—	3
Sum		3	2	4	4	3	2	18
Sum of Products		7	6	14	14	13	9	63
Average Weight		3.33	3.00	4.50	4.50	4.33	4.50	
Rank		5	6	3	2	4	1	

STEP 2 IN MAXIMIZING PRINCIPAL DIAGONAL

The iterative procedures illustrated in Figures 2 and 3 above were repeated for this sample problem several times. The successive rearrangements are shown in Figure 4 below.

FIGURE 4

Rank		1	2	3	4	5	6
Original Order		A	B	C	D	E	F
Iteration	1.	F	E	D	C	B	A
	2.	A	C	D	B	F	E
	3.	F	C	E	A	B	D
	4.	A	C	F	D	B	E
	5.	C	F	A	E	B	D
	6.	A	F	C	D	B	E
	7.	C	F	A	D	E	B
	8.	A	F	C	B	E	D
	9.	C	F	A	D	E	B
	10.	A	F	C	B	E	D
	11.	C	F	A	D	E	B

Successive Rearrangements in Maximizing Principal Diagonal

In Figure 4 you will notice that after iteration number 4 two groups emerge: a group containing persons A, C and F which upon further iteration only shift position or rank within their own group; similarly, a group consisting of persons B, E and D. The additional iterations 6 through 11 were computed to establish the position of each person within the subgroup to which he belongs. Notice also that after iteration number 7 an alternating solution appears. A and C and D and B alternately change positions. This gives us an answer to the question of when to stop the procedure.

The procedure is stopped (principal diagonal maximized) when (1) upon further iteration the arrangement does not change, or (2) further iteration results in an alternating arrangement of the columns. In terms of group structure these two conditions mean respectively: (1) a definite group structure exists in terms of the data being analyzed, or (2) two or more persons have equal status in the group or subgroup and their relative position is unimportant, again as defined by the data being analyzed.

The final arrangement of the sample sociomatrix analyzed in this paper is shown in Figure 5.

Summary

1. A method has been presented for systematically rearranging the sociomatrix so that group or subgroup structuring becomes more evident. The advantages of the method are:

FIGURE 5

	C	F	A	D	E	B
C	—	2	1			
F	2	—	1			
A	2	1	—			
D				—	1	2
E				2	—	1
B				2	1	—

FINAL ARRANGEMENT OF MATRIX

a. It is systematic: different investigators get the same results from the same data.
b. It is arithmetically simple and lends itself to machine solution. Computation checks are included.
c. The numerical values of the cell entries are not limited. Thus the method lends itself to many different types of sociometric situations: choice, ratings, etc.
d. The final solution contains the same information as the original and can be used for further types of analysis such as Festinger's analysis or factor analysis.
e. From a statistical viewpoint all of the information is being used.

The disadvantages are:

a. In its present form the iterative procedure converges slowly. Several refinements are being studied to see if the iterative process can be shortened.
b. In some situations group structure is not clearly defined by the method and no criterion for defining groups or subgroups is given.

BIBLIOGRAPHY

1. Beum, C .O., and Criswell, J. H. Application of machine tabulation methods to sociometric data. SOCIOMETRY, X:227-232, 1947.
2. Festinger, L. The analysis of sociograms using matrix algebra. *Human Relations,* II:153-158, 1949.
3. Forsyth, E., and Katz, L. A matrix approach to the analysis of sociometric data: preliminary report. SOCIOMETRY, IX:340-347, 1946.
4. Katz, L. On the matric analysis of sociometric data. SOCIOMETRY, X:233-241, 1947.
5. Luce, R. D., and Perry, A. D. A method of matrix analysis of group structure. *Psychometrika,* XIV:95-116, 1949.
6. Moreno, J. L. Who shall survive? Beacon House, 1st ed., 1934, 2nd ed., in press.

AN ADAPTATION OF HOLZINGER'S B-COEFFICIENTS FOR THE ANALYSIS OF SOCIOMETRIC DATA

R. Darrell Bock and Suraya Zahid Husain

Forsyth and Katz (1) have suggested depicting sociometric data by a matrix-like table in which the rows (or columns) are rearranged to reveal possible clusters of choices implicit in the original data. These clusters appear along the main diagonal of the table as groups of mutual choices bordered by unreciprocated choices.

This suggestion is similar to that of Burt (2) for identifying "clusters" of psychological tests. Here, a table of intercorrelations among tests is examined for "linkages" between pairs of tests—where two tests are considered linked if they show a correlation greater than a pre-specified value. The table of intercorrelations is then rearranged until the linkages cluster about the main diagonal.

Indeed, the problem of finding clusters of highly correlated tests within a larger test battery is of general interest in the factor analysis of psychological tests, and has been investigated by Cattell (3), Tryon (4), Maurer (5), Holzinger (6), and others. The methods proposed for meeting this problem are broadly inclusive, and may readily be applied to sociometric data in order to reveal subgroups of highly related persons.

It is the purpose of this paper to illustrate the application of one of these methods to a small sample of sociometric data. The technique used will be that of Holzinger, and is called the method of B-coefficients.[1]

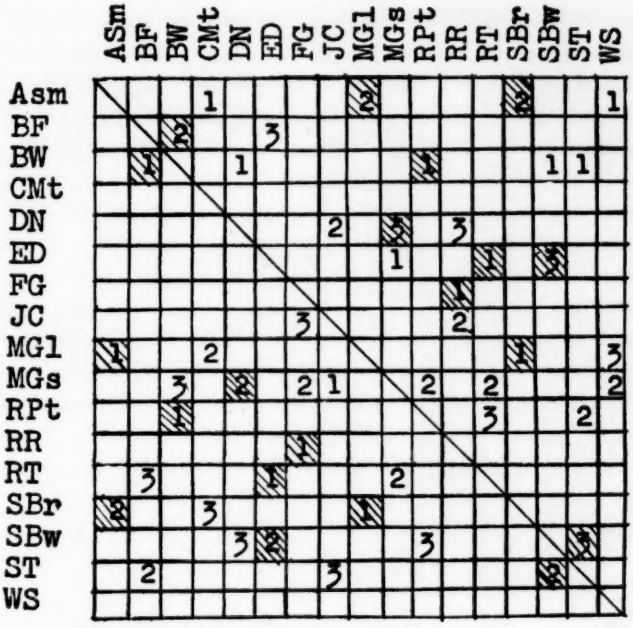
II

Table 1 represents choices made in a sociometric test given in the sixth grade of a Mid-Western public school. (This data is now on file at the Center for Intergroup Education of the University of Chicago.) Only the choices made by the girls are shown, but since there were no between-sex choices, the table represents a complete group. Individuals made two or three choices apiece, ranked in order of preference, under a choice criterion of working together on play groups for sociodrama.

In order to make these data accessible to the method of B-coefficients it must be converted to some measure expressing the degree of relatedness between each pair of individuals. This might be done by setting up any one of several different types of scoring procedure. The scale shown below

[1] See bibliography reference 6, pp. 23-34.

TABLE 1



Entries indicate rank of choice
Shaded figures indicate mutual choices[2]
(Criterion: Working together on play groups for sociodrama)

will be used for purposes of illustration. By means of this scale, mutual and unreciprocated choices will be scored as a quantity which will be referred to as "relatedness."

Unreciprocated Choices:

Rank	Score
1	3
2	2
3	1

Mutual Choices:

	1	2	3
Rank 1	9	8	7
2	8	7	6
3	7	6	5

[2] Mutual choices may be found conveniently on such a table by folding it along the main diagonal and viewing it against a strong light. Entries which coincide indicate mutual choices.

For example, if A gives B a first choice and B gives A a first choice, their relatedness is scored as 9. A first choice from A reciprocated by a second choice from B, or vice versa, is 8. Either a third choice from A unreciprocated by A or a third choice from B unreciprocated by A is scored as 1. In cases where neither person chooses the other, the relatedness is scored as zero. This scoring produces a relatedness measure for each possible pair of individuals in the group.

Because mutuals are weighted much more heavily than unreciprocated choices, the subgroups which will appear in the analysis will consist of a core of mutually related persons surrounded by persons who have chosen, or have been chosen by them.

Table 1 is re-scored with appropriate values of relatedness, which are then transferred to the lower triangular section of Table 2. For convenience in working with the B-coefficients, this table is expanded by copying the values below the main diagonal into the corresponding spaces above.

The persons represented in Table 2 may now be separated into subgroups by use of the B-coefficients.

Holzinger defines the B-coefficient, " . . . the coefficient of belong-

TABLE 2

	ASm	BF	BW	CMt	DN	ED	FG	JC	MGl	MGs	RPt	RR	RT	SBr	SBw	ST	WS	Sum
ASm		0	0	3	0	0	0	0	8	0	0	0	0	7	0	0	3	21
BF	0		8	0	0	1	0	0	0	0	0	0	1	0	0	2	0	12
BW	0	8		0	3	0	0	0	0	1	9	0	0	0	3	3	0	27
CMt	3	0	0		0	0	0	0	2	0	0	0	0	1	0	0	0	6
DN	0	0	3	0		0	0	2	0	6	0	1	0	0	1	0	0	13
ED	0	1	0	0	0		0	0	0	3	0	0	9	0	6	0	0	19
FG	0	0	0	0	0	0		1	0	2	0	9	0	0	0	0	0	12
JC	0	0	0	0	2	0	1		0	3	0	2	0	0	0	1	0	9
MGl	8	0	0	2	0	0	0	0		0	0	0	0	9	0	0	1	20
MGs	0	0	1	0	6	3	2	3	0		2	0	2	1	0	0	2	22
RPt	0	0	9	0	0	0	0	0	2			0	1	0	1	2	0	14
RR	0	0	0	0	1	0	9	2	0	0	0		0	0	0	0	0	12
RT	0	1	0	0	0	9	0	0	0	2	1	0		0	0	0	0	13
SBr	7	0	0	1	0	0	0	0	9	1	0	0	0		0	0	0	18
SBw	0	0	3	0	1	6	0	0	0	1	0	0	0	0		6	0	17
ST	0	2	3	0	0	0	0	1	0	0	2	0	0	0	6		0	14
WS	3	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0		6

ing . . . ", as "100 times the ratio of the average of the intercorrelations of a subset of variables to their average correlation with all other variables."[3] (Here, read *relatedness* and *persons* in place of *intercorrelation* and *variables*.)

Or, symbolically,[4]

$$B_{(u)} = \frac{200(n - p)S}{(p - 1)T}$$

where:

$B_{(u)}$ = the B-coefficient for the subgroup of persons being considered

n = the number of persons in the entire group

p = the number of persons in the subgroup being considered

S = the sum of the relatedness among the persons in the subgroup being conconsidered

and T = the sum of the relatedness between the persons in the subgroup and those in the rest of the group.

Holzinger and Harmon point out that at present "no sampling error formula is available by which to judge the significance of the difference between two successive values of B."[5] They recommend therefore that a careful study be made of all the experimental data on the variable to determine whether the drop may be considered significantly large.

The first subgroup is begun by selecting the two persons who share the greatest relatedness, e.g., individuals A and G. The next member of the subgroup is that person who has the greatest relatedness with the subgroup so far formed, in this case, with A and G. Succeeding members of the subgroup are added in this fashion, and, after each addition, the new B value is calculated. This process is continued, person after person, "until a sharp drop appears in the value of B."[6] When this occurs the last person is removed from the group and another tried. If the inclusion of any remaining person in the subgroup causes a similar drop in B, the subgroup is considered complete and the process is begun again with those persons not yet assigned.

---

[3] See bibliography 6, p. 24.

[4] *Ibid.*, p. 26.

[5] *Ibid.*, p. 27.

[6] *Ibid.*, p. 27.

Holzinger and Harmon multiply by 100 merely to remove decimal points. In the present case it would be sufficient to multiply by 10 to remove decimal points. This would make $B_{(u)}$ values more comparable to values usually obtained in this method. Harmon recommends multiplying by 10 and explaining why 100 is not used.

The regrouping of Table 2 is shown systematically in the following worksheet.[7] Since a number of persons are related by a value of nine—the highest possible value—there are several pairs which could begin the first subgroup. Because of this tie in scores, the first person of the first subgroup is taken as that person with the greatest total relatedness, shown in the "sum" column of Table 2. The second is that person who shares the greatest relatedness with the first, as explained above. The person with greatest total relatedness is used as a start here because there is a tie in highest possible score values and a start must be made in some manner. Actually any high value relationship could be used as a start.

It should be noted that in the worksheet the $B_{(u)}$ values are much higher than those ordinarily obtained for groups of tests. This is partly due to the fact that the index is multiplied by 100, a value included in the equation by Holzinger and Harman in order to eliminate decimal points. With the present scoring a value of ten could have been used for this purpose. Another reason for the high values is the use of zero as the measure of relatedness between two people not choosing each other. This value actually represents various degrees of relatedness. The inclusion of these values as zeros causes $B_{(u)}$ to jump to very high on occasion. Where no scored relatedness appeared between a given group and any other, $B_{(u)}$ would even become infinite and thus its values hard to interpret. This effect of zeros on the $B_{(u)}$ values is a drawback of this adaptation of the B-coefficient. Having noted this weakness of the adaptation of the method to social grouping, we can proceed to consider the advantages it offers.

On the basis of the completed worksheet, Table 2 is divided into five subgroups. These are rearranged until those between which there is considerable relatedness appear near each other along the main diagonal of the new table. The final arrangement is shown in Table 3.

III

The data may be left in the form of Table 3, in which the entries represent relatedness, or, alternatively, Table 1 with the original choices

[7] Cf., *Ibid.*, p. 32

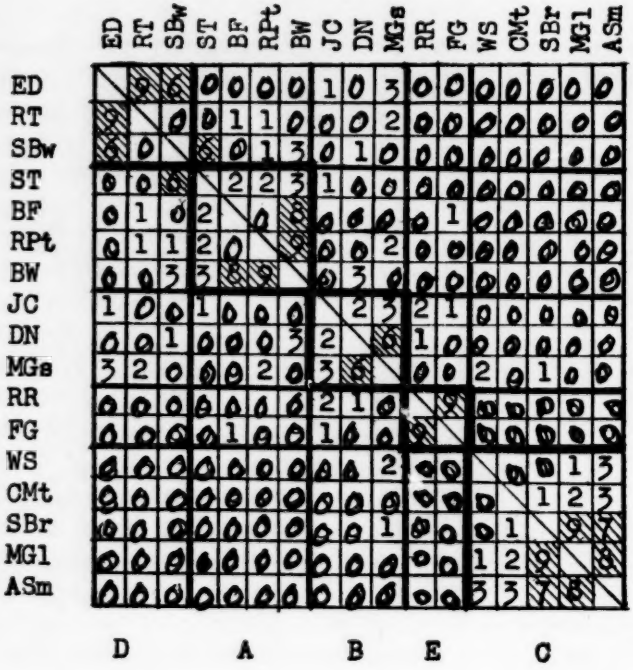
WORKSHEET

	Subgroup	p	L*	S	200x (n—p)	T	(p—1)T	$B(_u)$	Remarks
	BW, RPt	2	9	9	3000	23	23	1170	
A	BW, RPt, BF	3	8	17	2800	19	38	1250	
	BW, RPt, BF, ST	4	7	24	2600	19	57	1100	
	BW, RPt, BF, ST, SBw	5	4	28	2400	28	112	600	Rejected
	MGs, DN	2	6	6	3000	23	23	785	
B	MGs, DN, JC	3	5	11	2800	22	44	700	
	MGs, DN, JC, RR	4	3	14	2600	28	84	434	Rejected
	ASm, MGl	2	8	8	3000	25	25	960	
	ASm, MGl, SBr	3	16	24	2800	11	22	1306	No additional unassigned person shares any relatedness with this subgroup
C	ASm, MGl, SBr, CMt	4	6	30	2600	5	15	5200	
	ASm, MGl, SBr, CMt, WS	5	4	34	2400	1	4	20400	
	ED, SBw	2	6	6	3000	24	24	750	ST tested a second time here, but B value shows it should remain above
D	ED, SBw, RT	3	9	15	2800	19	38	1100	
	ED, SBw, RT, (ST)	(4)	(6)	(21)	(2600)	(21)	(63)	(870)	
E	FG, RR	2	9	9	3000	6	6	4500	Subgrouping complete

*L = the relatedness which the person who is entering brings into the subgroup, and $S_p = L_p + S_{p-1}$.

may be rearranged as indicated by the worksheet. In either case, the interpretation of the data may call attention to hypotheses which would be overlooked if the data were depicted by a sociogram alone. These hypotheses could be checked through further experimental data. Table 3, for example, suggests such questions as the following: 1) Does the classification of the larger group into subgroups correspond to any determinable social or psychological differences among the children represented? 2) What is the significance of the high degree of isolation of subgroup C? 3) Why do only a few children have relatedness with more than three subgroups? 4) Should subgroup E be interpreted as an isolated pair? 5) Is MGs, who has a total relatedness of twenty-two spread among four subgroups, in a

TABLE 3



more "healthy" social position than ASm, who has a relatedness of twenty-one confined entirely to subgroup C? 6) Can ASm be considered the leader of subgroup C? 7) Does the position of SBw, who has equal relatedness with subgroups A and D, imply anything about her role with regard to these two subgroups? 8) Are the cliques shown in Table 3 also apparent in the overt behavior of the group? 9) Will these particular configurations of subgroups continue to appear in the choices if the sociometric test is made with regard to different criteria or at a later time? . . .

The merit of an analysis of sociometric data based upon the concept of subgroups, such as illustrated above, rests largely upon the relevance of questions such as these to the better understanding of the complex pattern of attitudes between persons which the sociometric test reveals in the primary social group. Points which bear upon the meaning of subgroups in relation to net works, leadership structures, and other sociometric patterns have been treated by Moreno, and many others, but before we can progress in such analysis, much work is still needed to develop clear

and useful methods of singling out sub-groups. The method here proposed, it is hoped, may be adaptable to such advance.

Bibliography

1. Forsyth, E., and Katz, L. "A Matrix Approach to the Analysis of Sociometric Data: Preliminary Report", Sociometry, IX:340-7, Nov., 1946.
2. Burt, C. L. *The Factors of the Mind,* London University Press, London, 1940.
3. Cattell, R. "A Note on Correlation Clusters and Cluster Search Methods", *Psychometrica,* IX:169-84, 1944.
4. Tryon, R. C. *Cluster Analysis,* Edwards, Ann Arbor, 1939.
5. Maurer, K. M. "Patterns of Behaviour of Young Children as Revealed by Factor Analysis of Trait 'Clusters'", *Journal of Genetic Psychology,* 59, 177-84, 1941.
6. Holzinger, K. J., and Harman, H. H. *Factor Analysis,* University of Chicago Press, Chicago, 1941, pp. 23-34.
7. Moreno, J. L. *Who Shall Survive?* Beacon House, New York, 1st ed., 1934, 2nd ed., in press.

RACIAL ATTITUDES OF CHILDREN

MARION RADKE, *University of Denver, Denver, Colorado*
JEAN SUTHERLAND, *Wheelock College, Boston, Mass.*
PEARL ROSENBERG, *Cambridge, Mass.*

The practical situation out of which this research grew was an intercultural project sponsored by eight social and educational agencies belonging to the Hill District Community Council of Pittsburgh. The purpose was to assist the agencies in the development of intercultural programs. Research tools were developed to test the effectiveness of a group work program in changing the attitudes of Negro and white children toward each other.

SAMPLE

Negro and white children between ages seven and 13, an entire school population from grades two to six, were the subjects.[1] There were 475 Negro children and 48 white children. The school is in a low socio-economic area of Pittsburgh in which 75 to 85 percent of the population is Negro. Considerable effort has been made by the school to provide an atmosphere of cooperative living between the children of the two races, and to bring about social understanding in the child and adult populations.

PROCEDURE

Three types of data were obtained: (1) responses to a Projective Picture test, which involved the assignment of behavioral characteristics to Negro and white children in a series of photographs; (2) sociometric data on friendships and rejections using the photographs of the Projective Picture test; and (3) sociometric data on friendships and rejections of children in the school and neighborhood. The tests were administered as group tests. They are described below:

Picture Test: The Picture Test consists of 32 photographs of Negro and white children (eight Negro boys, eight Negro girls, eight white boys, and eight white girls) which are projected on a screen on slides of eight pictures each. Each slide has two boys and two girls of each race placed in two rows with race and sex alternated, the photographs lettered from A to H. Each position is taken by a different sex and race on each of the

[1] For the first analysis of cleavage based on experimental investigation of sociometric patterns, see J. L. Moreno, *Who Shall Survive?* Beacon House, Inc., 1st ed., 1934, 2nd ed., in press. Pp. 60-64, 346-348, ff.

four slides. The slides are shown in the order: IV, I, II, III, IV, I, II, and so on (IV is given first as a practice situation). A behavioral description is presented orally with each slide and the subjects are asked which child in the pictures is being described. There are 24 descriptions. The slides are repeated in order until all the descriptions have been used.

From the research literature on attitudes toward the Negro, twelve common stereotypes were selected, such as "lazy," "dull," "dishonest," etc., and descriptions based on these stereotypes were used in the tests. Each description was paired with an opposite characteristic, thus: "One of these children always come to school dirty", and "One of these children is always neat and clean".

DIRECTIONS FOR ADMINISTRATION OF PICTURE TEST:

We are going to look at some pictures today. It is going to be a game to see if you can tell what people are like just by looking at their pictures. It is not a test, but you are to try hard to do your best.

We are going to look at pictures of boys and girls whom you have not seen before. I'm going to tell you about some of these children. Try to guess which boy or girl I'm telling you about. When you think you know which it is, put the answer on this paper. Don't let anyone know your answer.

Let's try together to see how it goes. Here is the first slide (Put on slide IV). You see each picture has a letter on it—A,B,C,D,E,F,G,H pointing to the letters). We'll call each picture by the letter it has on it.

At the top of your answer sheet is a space marked "example". Put your answer to the try-out question in that space.

Now, I'm going to tell you about one of these children. Listen carefully. *One of these children can run faster than anyone else in the school.* Who do you think it is? (Repeat statement.) Put the letter of that child's picture in the top space marked "example". (Ask for questions. Take off slide IV.)

You will see many pictures, some of them you will see more than once. You may choose a picture as many times as you like. You may choose a boy or a girl.

Now we are ready to begin with number one. Ready? (Put on slide I, and give statement number one. Read it twice.) Which child do you think it is? Put the letter of that child's picture in the space after number one.

Now we'll do number two. (Put on slide II. Repeat procedure for the first 24 statements. Change slide each time, making certain slides are in correct order: slide I for statement 1, slide II for statement 2, slide

III for statement 3, slide IV for statement 4, slide I for statement 5, and so on. Each slide is shown for six statements.)

STATEMENTS ON PICTURE TEST:

One of these children:

1. is the smartest in the school.
2. never bothers to do anything and is a very lazy child.
3. is very nice and kind.
4. is always shouting and yelling around the school yard.
5. is the bravest of anyone in school and helped put out a fire one day.
6. started a fight in the school yard.
7. is always neat and clean.
8. is not very smart and cannot answer any questions on tests.
9. has very nice manners.
10. pushes and crowds ahead of all the other children in line into the movie house to try to get the best seat.
11. never fights if it can be helped, but usually wins if there is a fight.
12. stole an apple from the grocery store yesterday.
13. is always fair and waits turn with the other children.
14. tore a book one day, but told the teacher somebody else tore it.
15. never swears or uses bad words.
16. always comes to school dirty.
17. always tries to do his or her best.
18. is very mean.
19. does not tell lies.
20. seems to be afraid of everything, even a shadow.
21. never shouts and screams when not supposed to.
22. has no manners at all, doesn't know how to behave.
23. found a purse on the street-car with five dollars in it and gave it back to the person who lost it.
24. is always swearing and using bad words.

Preliminary testing of the Picture Test involved the following steps: Two hundred photographs of Negro and white children, seven to 14 years of age, were presented to 30 adult white judges. The pictures were separated for sex and race. The judges were asked to sort the pictures into categories of pleasant, neutral, unpleasant. Pictures which were rated pleasant by the judges or pleasant by most and neutral by several of the judges were used. A preliminary test was set up in which pictures of white children were mounted on one poster and pictures of Negro children on another. Twenty Negro children and twenty white children were given the test, with the photographs of the whites alone, and then with the photographs of the Negroes alone. In this way, the frequency with which desirable and undesirable descriptions were assigned to each picture was obtained when

the factor of race was held constant. On the final test, pictures appearing on the same slide were alike in the ratio of desirable to undesirable descriptions received on the pre-testing. In this way the effects of factors other than race were minimized. Thus if race is not a factor affecting the evaluation of children, pictures of each race should be selected equally often for desirable and undesirable descriptions. If a preponderance of desirable or undesirable statements is attributed to one race it may be assumed to be evidence of stereotyping, prejudice, or friendly or unfriendly feelings toward that race.

The test is scored by subtracting the number of positive statements given one race from the number of negative statements given the same race. If twelve Negro pictures are chosen, eight positive and four negative, the score is plus four. If six are positive and six negative, the score is zero. The score on the white pictures is the reverse sign of the score on the Negro pictures. This scoring method is acceptable only if the children choose approximately equal numbers of the two races. If one or the other race is greatly over- or underchosen, this factor, as well as the proportion of positive and negative statements given to each race, must be taken into account. For this reason, the number of times out of 24 that Negro pictures were chosen was tabulated. The results, listed below, seem to justify the use of this scoring method. Only a very few children greatly under- or over-chose one race.

Number of Negro pictures chosen by:	*Average*	*Range*
White boys	10.7	3 — 15
White girls	10.8	7 — 17
Negro boys	11.4	5 — 16
Negro girls	12.2	8 — 19

The *Picture Sociometric test*[2] involves the use of the same photographs as the Picture Test described above. The subject is asked which child in the pictures he would most like to have for a friend (slide I). Second and third choices are made on slides II and III. Following these choices he is asked to select three children whom he would not like as friends (slides I, II, III).

Sociometric data on the child's real-life acquaintances were obtained

[2] The original term used by Moreno was Sociometric Picture Test; see J. L. Moreno, "Sociometry and the Cultural Order," p. 329, SOCIOMETRY, VI: 299-344, August, 1943. This term seems less awkward and is therefore recommended by the editor to substitute for the phrase, Picture Sociometric Test; reactions of readers to this suggestion would be appreciated.

a week before the two preceding tests were given. The child recorded, on a prepared form, the names of three children desired as friends and three rejected. He indicated whether the child belonged to his class in school, belonged to a different grade, or lived in the community but did not go to the same school.

All tests were administered to children in groups by someone other than the teacher. Assistance was given the younger children on all tests.

Findings

Picture Tests: The children's selection of photographs to correspond to descriptions in the picture test provide data on the extent to which each race is perceived in specific stereotypes, the degree to which the Negro children "accept' derogatory stereotypes of their own group, and the friendly or unfriendly feelings which exist between the Negro and white children. The data from the Picture Test are presented in Table I, showing the percentage of children scoring from minus twelve (all negative statements assigned to Negro pictures and all positive statements assigned to white pictures) to plus twelve (all negative statements assigned to white pictures and all positive statements assigned to Negro pictures). The mean scores of both Negro and white children at each grade level are minus scores, that is, undesirable descriptions are given more frequently to Negro pictures than to white pictures.

The distributions of scores for Negro and white children differ markedly. The Negro children's scores are distributed nearly symmetrically from plus ten to minus ten, with fifty to sixty percent of their scores in each grade between plus one and minus four. There is a downward trend in mean scores from —1.33 in grade two to —2.22 in grade five, which means a steady increase in the assignment of undesirable characteristics to Negro pictures. The sixth grade Negro children do not follow this trend. (This grade is atypical in its responses to the other two tests also.) The test responses of the white children show even greater divergence from a half and half distribution of desirable and undesirable descriptions for Negro and white photographs. The scores of the white children range from plus four to minus twelve, with a clustering of cases between minus two and minus four. The percentages drop off abruptly in the positive direction with only five cases scoring above the middle zone. In each grade, the white children assign many more undesirable than desirable characteristics to Negro photographs.

A comparison of the mean of the Negro children in the three lower

TABLE I

PICTURE SOCIOMETRIC TEST

Percentage of Negro and white children scoring at each level on the test, and mean scores for each grade.

	Negro Children						White Children					
	Grades						Grades					
	2	3	4	5	6		2	3	4	5	6	
Score												
+11,12	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
+8,9,10	0.0	.8	0.0	1.2	1.2		0.0	0.0	0.0	0.0	0.0	
+5,6,7	3.0	4.8	1.7	3.5	2.4		0.0	0.0	0.0	0.0	0.0	
+2,3,4	15.1	14.5	12.6	10.5	23.2		0.0	0.0	27.3	10.5	0.0	
+1,0,—1	36.4	27.4	34.5	37.2	31.7		0.0	13.3	9.1	21.1	30.0	
—2,—3,—4	36.4	27.4	26.9	23.2	24.4		0.0	26.7	45.4	42.1	30.0	
—5,—6,—7	9.1	17.8	19.3	16.3	14.6		2*	33.3	9.1	15.8	20.0	
—8,—9,—10	0.0	7.3	4.2	8.1	2.5		1*	20.0	9.1	10.5	20.0	
—11,—12	0.0	0.0	.8	0.0	0.0		0.0	6.7	0.0	0.0	0.0	
Mean Score	—1.33	—1.72	—1.92	—2.22	—1.43		—7.33	—5.06	—1.36	—2.84	—4.00	
N	33	124	118	86	82		3	15	11	19	10	

* Because of the very small N, these figures are not given in percentages.

grades (—1.76) with the mean of the white children in the same grades (—4.14) reveals a statistically significant difference (t = 3.50, 1% level). Similarly, the means of Negro children (—1.83) and white children (—3.24) of the fifth and sixth grades, show a significant difference ("t" = 7.01, 1% level). Both differences are in the direction of more undesirable descriptions being assigned to Negro pictures by white children than by Negro children.

The fact that Negro children assign undesirable characteristics to the Negro pictures (when the white children assign almost no undesirable characteristics to white pictures) suggests ambivalence on the part of the Negro children toward their own race. This is in line with the theoretical predictions of Lewin.

The more "positive" attitude toward their own race expressed by the sixth grade Negro children perhaps reflects a rebellion on their part against the acceptance of the derogatory stereotypes of the Negro. The psychological situation of the older Negro children is undoubtedly one in which racial discrimination plays an increasingly important role. This can lead to conflicting reactions in the children: both increased doubts about the goodness of their own group, and increased antagonism toward the white group and unwillingness to accept inferior social status because of race.

The data from the white children show clearly their acceptance of the attitudes of their culture toward the Negro. The fact that so few undesirable characteristics are assigned to the white photographs by the white children leaves open many questions regarding the frame of reference with which they view the Negro and white races.

The test provides not only a measure of the negative and positive attitudes but also of the specific stereotypes of the two groups. The frequency with which each of the descriptions in the test was assigned to white and Negro pictures was determined, and descriptions which were assigned to one race by more than 70% of the children of either race are listed in Table II.

In not a single case is a "good" description given more frequently to Negro pictures.

Picture Sociometric Test: Choices and rejections of the photographs provide an interracial sociometric pattern on an "abstract" level. It is "abstract" in the sense that here such variables as personality differences among the children, differences in familiarity, relative availability, and adult pressures, are eliminated. Presumably the child's choice of a picture is determined only by differences in race and sex. The data from this test are given in Tables III, IV, and V.

TABLE II

FREQUENCY OF ASSIGNMENT OF DESCRIPTIVE PHRASES TO RACIAL GROUPS

Descriptive Phrase	Percent of White Subjects Assigning Phrase to:		Percent of Negro Subjects Assigning Phrase to:	
	White Picture	Negro Picture	White Picture	Negro Picture
One of these children is always neat and clean	90	10	64	36
One of these children never swears or uses bad words	86	14	80	20
One of these children is the smartest in school	84	16	80	20
One of these children is always fair and waits his turn	79	21	56	44
One of these children found a purse on the street car . . .	77	23	55	45
One of these children does not tell lies	74	26	61	39
One of these children is very nice and kind	74	26	61	39
One of these children started a fight . . .	28	72	32	68
One of these children always comes to school dirty	32	86	21	79

TABLE III

PICTURE SOCIOMETRIC TEST

Choices and Rejections of Negro and White Pictures

Group	Percent of Choices to:		Percent of Rejections to:	
	Negro Pictures	White Pictures	Negro Pictures	White Pictures
Negroes:				
Grades 2-3-4	42	58	62	38
Grades 5-6	57	43	53	47
Whites:				
Grades 2-3-4	9	91	68	32
Grades 5-6	12	88	57	43

Since there are equal numbers of white and Negro pictures, both races have equal probabilities of being chosen and being rejected if there is no racial partiality. The white children, however, are not impartial. In their

TABLE IV
PICTURE SOCIOMETRIC TEST
Choices and Rejections in Terms of Race and Sex

Group	Percent of Choices to:				Percent of Rejections to:			
	Negro Boys' Pictures	Negro Girls' Pictures	White Boys' Pictures	White Girls' Pictures	Negro Boys' Pictures	Negro Girls' Pictures	White Boys' Pictures	White Girls' Pictures
Negro Boys:								
Grades 2-3-4	44	6	38	12	31	30	20	19
Grades 5-6	53	7	31	9	24	26	30	20
Negro Girls:								
Grades 2-3-4	9	26	10	54	33	28	12	26
Grades 5-6	17	39	5	39	23	31	20	26
White Boys:								
Grades 2-3-4	15	0	67	18	41	37	11	11
Grades 5-6	11	2	47	40	38	22	9	31
White Girls:								
Grades 2-3-4	0	5	6	89	26	37	31	6
Grades 5-6	2	9	11	78	49	16	13	22

choices of friends, only nine percent of the younger and twelve percent of the older children select Negro pictures. Choices of Negro children are close to a half and half distribution of Negro and white pictures (42% and 57% of Negro pictures are chosen by younger and older children, respectively). While rejections appear to be less sensitive measures of group preferences than choices of friends, the same trends appear. Slightly more than half the rejections by both Negro and white children are of Negro pictures. The percentage of rejections of Negro pictures is higher than the percentages of choices of Negro pictures in all but the sixth grade Negro children. For the latter group the relative proportions are reversed with 65% of the friendship responses and 49% of the rejection responses given to Negro pictures.

The data from the Picture Sociometric Tests are consistent with the data from the Picture Test, even to the point of atypical responses of the sixth grade Negro pupils, who, on both tests, indicate more acceptance of their own race than do the younger Negro pupils.

The pattern of each child's responses on the Picture Sociometric Test was analyzed in terms of the racial distribution of his choices and rejections.

For example, a child could select Negro children for three choices of friends and white children for three rejections; or he could choose Negroes and whites and reject Negroes and whites; or he could choose only whites and reject only Negroes. The patterns of choices and rejections are given in Table V.

TABLE V
PICTURE SOCIOMETRIC TEST
Patterns of Choice and Rejection of Friends

Whites			Negroes		
Choices to:	Rejections to:	Percent	Percent	Choices to:	Rejections to:
Whites only	Negroes only	34	6	Whites only	Negroes only
Whites only	Both races	31	10	Whites only	Both races
Whites only	Whites only	10	4	Whites only	Whites only
Both races	Negroes only	12	16	Both races	Negroes only
Both races	Both races	12	34	Both races	Both races
Both races	Whites only	1	9	Both races	Whites only
Negroes only	Negroes only	0	5	Negroes only	Negroes only
Negroes only	Both races	0	11	Negroes only	Both races
Negroes only	Whites only	0	5	Negroes only	Whites only
Total		100	100		Total

Entries in Table V are arranged in order from the pattern expressing the extreme pro-white and anti-Negro attitude (at the top) to lesser degrees of the same attitude, through a neutral point in which both races appear in choices and rejections, to increasing degrees of anti-white and pro-Negro positions. The highest frequency in this scale for Negro children (34%) is at the racially balanced point of having both races in the categories of friends and rejections. From this high point the frequencies distribute themselves symmetrically in both directions toward the pro-white and anti-Negro end of the scale as well as toward the anti-white and pro-Negro end. For the white children the highest frequencies (34% and 31%) occur in patterns of all white friends and all or some Negro rejections. Relatively few white children show biracial patterns of friendships, and virtually none appears in patterns beyond the neutral point of a Both-Both pattern.

The choice-rejection pattern with the greatest racial bias is that in which the child selects three friends from his own race and rejects three children of the other race. Whereas this is the dominant pattern of the white children, it occurs in only five percent of the Negro children.

The reverse pattern of choosing three members of the other race and rejecting three members of own race occurs only in the Negro group: six percent of the Negro children follow this pattern. For these children their own racial group appears to have little positive value.

If the patterns of children's choices of friends are considered, irrespective of rejections, choices of friends are made entirely within own racial group by 75 percent of the white children and 21 percent of the Negro children. Choices which include both races are made by 25 percent of the white children and 59 percent of the Negro children. Choices of friends exclusively outside one's own racial group, which would be predicted from minority members who possess feelings of "self hate" and strong needs for acceptance by the higher status group, are made by twenty percent of the Negro children. One would not expect such a pattern of choices by members of the majority group. This expectation is borne out by the choices of the white children. None appears in this category. Thus the racial cleavage is not created equally by the white and Negro children. It is mainly based on the choices of the white children. The Negro children seek friendship in both races.

Previous findings, both experimental and observational, have established the fact of sex cleavage in children's friendships. This factor may be expected, therefore, to influence the responses to racial differences. Since a difference in either race or sex may constitute a barrier to choice, fewer choices of friends should be expected in categories in which a child chooses outside his sex and outside his race. These race-sex barriers may be of different strengths for the two sexes in each race.

Negro and white children respond differently across race-sex lines. The Negro children give more like-sex choices than like-race choices. The white children, on the other hand, prefer choices within the white race regardless of sex. Choices which are across both sex and race lines occur least frequently. The only exception is the Negro boys who, instead of choosing more Negro girls than white girls, show a slight tendency to prefer white girls to Negro girls. The generally unfavored position of the Negro girls is evident in the reactions of the white boys toward them, and also in the degree to which the Negro girls express self-preference (i.e., choose pictures of Negro girls). Their choices of white girls outnumber their choices of Negro girls. These data, though inconclusive, suggest a difference in social-sex roles in the problems of racial belonging: a greater acceptance by the Negro girls than by the Negro boys of the majority group's devaluation of the minority.

The data on race-sex differences on the rejections do not show consistent trends. The rejections by Negro boys and girls do not seem to be appreciably influenced by race or sex. White children tend to reject more Negro than white children regardless of sex.

Sociometric Test: The Sociometric Test involving reactions to children in the classroom or in the community presents a quite different situation from the Picture Sociometric Test. In the Picture Sociometric Test it might be expected that the child's choices are closer to his ideal or wish level with respect to racial associations than in the real life situation. In real life, many factors other than the child's wishes enter into the situation, such as the opportunity for social contact with each race, the individual personalities, the social pressures imposed by the adult society. Also, with different circumstances of real life the factors influencing behavior toward race vary. For example, the white child in a Sunday school class would probably not think of taunting the Negro child in class. But on the play lot or at the drug store fountain he may thrill with a feeling of superiority as he calls "nigger" or unmistakably shuts out the Negro child. Often the school provides a setting for interracial behavior which is different from the community pattern. In the northern city, for example, the school may have Negro and white students and faculty participating equally. But just beyond the school door social codes demand separate and distinctly different social roles for Negro and white.

Situational differences should be reflected in the friendship choices. In the Sociometric Test the children were free to choose and reject children from the classroom, the school as a whole, or the community. The data were analyzed with respect to these three locations, and the data from the Sociometric Test were compared with the data from the Picture Sociometric Test.

Since the white children form only 10 to 15 percent of the school population, if they are seeking to choose friends within their own race (as the Picture Sociometric Test data suggested), they should be expected to select children from outside the classroom and the school more often than the Negro children. The percentages of choices of friends in each of the locations are given on the following page. These figures indicate a small trend in the indicated direction. Slightly more of the white children select friends outside the classroom and school than do Negro children.

The proportions of choices and rejections within each race are given in Table III. The Negro children tend strongly toward intraracial choices

in the classroom, school, and community. The white children show a marked difference in the proportion of Negro children chosen in the class and outside the class in school or community. In the classroom the majority of the choices by the white children are of Negro children. There is an age trend however, in which this majority decreases sharply: the younger white children give 76 percent of their choices of friends to Negro children, whereas the older children give only 53 percent. These choices are made in classrooms with 85 percent Negro population.

	Classroom	School Outside Classroom	Community
By Negro children			
Grades 2-3-4	70	22	8
Grades 5-6	48	29	23
By white children			
Grades 2-3-4	58	19	23
Grades 5-6	50	22	28

When the chosen child is selected from another class or from the community, the separation of races is almost complete. The choices outside the classroom are likely to be the child's out-of-school hours playmates, in which case parental and community standards exert greater influence. Never in the community and only rarely outside the classroom (eight percent of the younger white children) do the white children choose Negro children as friends. The racial line outside the classroom is crossed only slightly more often by the Negro Children.

It must be remembered in interpreting the rejection data that rejection, like choice of a friend, depends upon some degree of acquaintance with the child indicated. For this reason, if there is little social exchange between the races, there are likely to be few children rejected in the other racial group. This fact seems to be demonstrated in the data. High intraracial choice of friends outside the classroom is not balanced by high extraracial rejection. Negro children reject mostly Negro children, white children reject all white children. Only in the sixth grade Negro children is there a sharp divergence. Rejection of white children in the classroom in 58 percent of the responses seems to reflect the increased hostility toward the white group, noted earlier in the reactions of the sixth grade Negro children. Only where the situation creates Negro-white interaction, as in the classroom, do the white children name Negro children as those whom they do not want as friends.

TABLE VI

SOCIOMETRIC TEST

Choices and Rejections in the Classroom, School, and Community

Group	Percent of Choices						Percent of Rejections					
	Classroom		School Outside Classroom		Community		Classroom		School Outside Classroom		Community	
	Negro	White	Negro	White	Negro	White	Negro	White	Negro	White	Negro	White
Negro Children:												
Grade 2	95	5	100	0	(3/3)*	(0/3)*	95	5	(4/6)*	(2/6)*	(2/2)*	(0/2)*
Grade 3	89	11	99	1	96	4	94	6	94	6	80	20
Grade 4	96	4	100	0	97	3	99	1	100	0	(7/7)*	(0/7)*
Grade 5	91	9	98	2	97	3	94	6	100	0	100	0
Grade 6	91	9	98	2	84	16	42	58	95	5	75	25
White Children:												
Grades 2-3-4	76	24	8	92	0	100	87	13	(0/3)*	(3/3)*	(0/7)*	(7/7)*
Grades 5-6	53	47	0	100	0	100	93	7	(0/4)*	(4/4)*	0	100

* Where N is below 10, the proportions have not been converted to percentages.

An analysis of sex cleavage within racial cleavage revealed no consistent differences among the subgroups such as those found in the Picture Sociometric Test.

When the sociometric data are analyzed according to the racial distribution in each child's choices and rejections, the patterns contrast sharply with the patterns in the parallel analysis of the Picture Sociometric data (Table V). In a school situation in which white children constitute a numerical minority, their actual friendship choices include many more Negro children than their wish level choices on the Picture Sociometric test. The patterns of choices and rejections on the Sociometric test are presented in Table VII. Thus, 80 percent of the younger white children and 45 percent

TABLE VII
SOCIOMETRIC TEST
Patterns of Choice and Rejection of Friends

Pattern of Selection		Negro Children Grades		White Children Grades	
Choices of	Rejections of	2, 3, 4	5, 6	2, 3, 4	5, 6
Whites only	Negroes only	1%	1%	0	10%
Whites only	Both races	0	0	0	15%
Whites only	Whites only	0	0	12%	25%
Whites only	Part omitted*	0.3%	1%	8%	5%
Both races	Negro only	11%	6%	12%	5%
Both races	Both races	4%	2%	28%	15%
Both races	Whites only	0.3%	0	0	0
Both races	Part omitted*	2%	2%	20%	15%
Negroes only	Negroes only	60%	55%	16%	0
Negroes only	Both races	19%	19%	4%	10%
Negroes only	Whites only	0.3%	0	0	0
Negroes only	Part omitted*	2%	14%	0	0

* Some children gave choices, but omitted rejections.

of the older white children select one or more Negro classmates as friends, while on the picture selections only 25 percent include Negro children among their friends. In the real life situation all three friends are chosen from the white race by 20 percent of the younger white children and 55 percent of the older white children, compared with 75 percent on the Picture Sociometric test. Twenty percent and ten percent of the younger and older children respectively choose only Negro children for their three friends. This pattern does not appear in the picture choices by the white children.

For the Negro children the discrepancy between the wish level and real life is in the opposite direction. On the wish level there is expressed much greater desire for friends among white children than in the school and community: Only 19 percent of the younger children and 12 percent of the older children name white children in the school and community whom they want as friends, whereas 79 percent choose pictures of white children. While 21 percent of the Negro children select only Negro pictures for friends, 81 percent and 88 percent of the younger and older children respectively choose exclusively within the Negro race among their own contemporaries.

The differences which appear between the pictures and the real life choices and rejections seem to be determined by the situational requirements—the large proportion of Negro children in the school, and the cultural values concerning race. The discrepancies point out the need for somewhat different educative procedures of the Negro and white children, since the reactions of the Negro and white children toward their own and the other races differ, not only in the behavior toward each race (sociometrically) but in the goals of the two groups. The goals are in opposite directions. The white children are directed away from interracial association; the Negro children are desirous of more associations with white children.

The data agree in general with the previous findings of Criswell (2) and Horowitz (3). Horowitz obtained various preference expressions of white boys for pictures of Negro and white boys. Preference for whites was obtained, appearing even in kindergarten and increasing through grade eight. A group of sixth grade Negro boys, compared with sixth grade white boys on the same test, showed less strong but statistically significant preference for whites.

Criswell applied the sociometric test to choices of companions in the classroom in schools of mixed race, kindergarten through grade eight. White children showed significant preference for whites beginning in kindergarten and increasing with grade. Negro children showed little race preference until grade five, when they exhibited significant preference for their own race, less strong, however, than the whites' self-preference. The analysis suggested that Negroes accepted white prestige but increasingly withdrew into their own group as a response to white rejection. There were also indications that whites greatly in the minority chose into the Negro group partly by necessity because of their small numbers. Another aspect, apparently, of the effect of the social situation on race stereotypes was the fact that in this study preference for one's own race was uniformly less

strong than preference for one's own sex, so that classroom groups separated into groups of boys and girls, each of those groups separating secondarily into Negroes and whites.

The contrast between Criswell's and Horowitz's results is borne out by the present study which shows distinctly that race preference on a symbolic level tends to differ in strength and direction from preference expressed in the actual social situation. Preferences on the abstract picture level conform more to the community pattern of stereotypes than do real-situation choices. This finding is of considerable potential significance for research on the reduction of intergroup tensions.

Summary and Conclusions

In a public school of Negro and white children, in which the white children constitute only 10 to 15% of the population, children's evaluations of racial differences were studied. Test situations provided data on the children's evaluations of personality characteristics in each race and on their choices and rejections of friends in each race.

The white children in all the situations and at all ages (7 to 13 years) express strong preference for their own racial group. This is particularly the case when their choices between Negro and white children as friends are on an abstract or wish level (Picture Sociometric Tests). A school situation in which Negro children are in the numerical majority and in which teachers and administration attempt to create an atmosphere of racial understanding greatly increases the number of interracial choices from the white children. This interracial choice is limited strictly to the classroom, and does not carry over to the community in which the proportions of Negro and white populations are the same as in the school. The white children express unfavorable attitudes toward Negroes by assigning the undesirable behavior characteristics to the photographs of Negro children. These generalizations for the white children apply to each of the age levels studied. Because of limited numbers it was not possible to study the effects of age in any detail.

The responses of the Negro children on the assignment of behavior characteristics to their own race and to the white race show a much less positive attitude toward their own race than is shown by the white children toward the white race. Like the white children, the Negro children show a readiness to assign the undesirable characteristics to the Negro. What seems to be self-rejection and ambivalence toward their own race appears again in the Negro children's responses to the photographs on questions of

preferred friends. Here roughly half of the rejections are of own race. Their choices within the Negro race on the wish level are much lower than in the classroom and community, where 84 percent to 100 percent of their choices are of Negro children.

The attractions and repulsions expressed by both Negro and white children on the questions of friendships are related to their perceptions of the personality characteristics of each race. These perceptions in which the undesirable characteristics are ascribed to the Negro children and the desirable to the white are consistent with the wish of both Negro and white children to have white children as friends. The negative self-concept of the minority member which plays such an important role in the dynamics of adult minority- majority group conflicts, is thus demonstrated to have its beginnings in childhood.

The results of this study emphasize the early patterning of social perceptions and reactions to the Negro and white races. The implications of this study are clear. They point to the necessity for attacking problems of prejudice with very young children, and for preventive intercultural education programs in the very early years.

References

1. Clark, K., and Clark, M. "Racial Identification and Preference in Negro Children," in T. M. Newcomb and E. Hartley (edrs.), *Readings in Social Psychology.* Henry Holt and Co. 1947.
2. Criswell, Joan Henning. "A Sociometric Study of Race Cleavage in the Classroom." *Archives of Psychology,* No. 235, 1939.
3. Horowitz, Eugene. "The Development of Attitudes toward the Negro." *Archives of Psychology,* No. 194, 1936.
4. Moreno, J. L. *Who Shall Survive?* Beacon House Inc., 1st ed., 1934; 2nd ed., in press.
5. Moreno, J. L. "Sociometry and the Cultural Order," *Sociometry,* VI: 299-344, August, 1943.
6. Radke, M., Trager, H., and Davis, H. "Social Perceptions and Attitudes of Children." *Genetic Psychology Monographs,* 1949, 40: 327-447.

THE SOCIOMETRIC APPROACH TO SOCIAL CASE WORK

J. L. Moreno

Sociometric Institute, New York

1. *Philosophical Position.* Man is more than a psychological, social or biological being. Reducing Man's responsibility to the psychological, social or biological department of living makes him an outcast. Either he is co-responsible for the whole universe or his responsibility means nothing. The life and future of the universe is the only thing which matters—more important than the life and death of man as an individual, as a particular civilization or as a species. A case worker worthy of his profession has, therefore, the task to help his client to achieve and maintain a clear understanding as to the part he plays in the universe, on the physical, psychological, social, cultural, asthetical, ethical, and cosmic plane.

Spontaneity operates in the present, now and here; it propels the individual towards an adequate response to a new situation or a new response to an old situation. It is strategically linked in two opposite directions, to automatism and reflexivity, as well as to productivity and creativity. It is, in its evolution, older than sexuality, memory or intelligence. Although the most universal and evolutionarily the oldest, it is the least developed among the factors operating in Man's world; it is most frequently discouraged and restrained by cultural devices. A great deal of Man's psycho- and sociopathology can be ascribed to the insufficient development of spontaneity. Spontaneity "training" is therefore the most auspicious skill to be taught to case workers in all our institutions of learning and it is his task to teach his clients how to be more spontaneous without becoming excessive.

There is ample evidence that the spontaneity of the infant has "something to do" with his arrival in this world. During pregnancy he warms up to the act of birth. The length of gestation is largely determined by the genotype of the foetus and not by the dam of the carrying individual. The infant wants to be born. Birth is a primary, and creative process. It is positive before it is negative, it is healthy before it is pathological, it is a victory before it is a "trauma".

2. *Early Definition of Interpersonal Relations.* "It is a meeting of two: eye to eye, face to face. And when you are near I will tear your eyes out and place them instead of mine, and you will tear my eyes out and will place them instead of yours; then I will look at you with your eyes and you will look at me with mine." (Transl. from "Einladung zu einer Begeg-

nung", by J. L. Moreno, p. 3, Vienna, 1914.) Interpersonal relation is here defined as a two-way relation in the full sense of the word, involving the potentialities of "role reversal", in contrast with the psychoanalytic situation which is a rigid, one-way relation characterized by an inequality of status of the two participants.

3. *Sociometric Base of Social Work.* Man does not live alone and does not get sick by himself. His problems develop in groups, formations of a special sort; in modern society they are not identical with our social institutions, the family, the occupational, the religious groups; they are fleeting and mobile, difficult to trace and to pin down. The people influencing the dynamic social status of a person are often a queer collection of individuals. Many of them do not belong to the formalized groups around the person in question. However, the mental and physical equilibrium of an individual depends to a considerable degree upon the dynamic interplay of these various individual and social forces. It is obvious that without the knowledge and ability to mobilize the sociometric matrix in behalf of an individual, adequate social case work is not possible or at least greatly handicapped. The sociometric matrix is the social depth-level; in the case of an individual it is called his social atom. As long as the sociometric matrix was considered identical with the specific family, neighborhood, or any other face to face group—as in the more rigidly regulated societies of the past—social case work was just family case work or case work of the predominant social institution. The mobility in the modern universe being world-wide, the expansion of a particular sociometric matrix may extend world-wide although consisting only of a few individuals. From the point of view of sociometry interviewing an individual alone or one or another member of his family as practiced by psychoanalytically oriented workers is at least methodically crude. Case workers intuitively feel the need for helping their clients to explore their sociometric matrix but they are held back by the individual centered psychoanalytic doctrine, and by lack of a handle as to how to map the matrix of a person. The handle is the sociometric test; it is rather an experiment than a test and consists in determining the active social feelings which people have for each other in respect to a certain criterion. The crux of the experiment is, first, how to start it rather than how to analyze the results; second, how vital the criterion is; if the criterion is dying together he chooses or rejects the members of a suicide battalion with the probability of never returning from battle; or the criterion is working together depending upon whom he chooses or rejects to work with. The sociometric base of a group is its primordial form,

private and collective factors are neatly interwoven; *the sociometric base cannot be by-passed without taking the risk that the whole house of a healthy social order is built on sand.*

Once this base is uncovered and the individual integrated into the sociometric matrix reigning his destinies at the moment, the case worker must realize that this integration, however satisfactory on that plane, is still *partial* and, together with the client he should prepare the next step: the integration of the sociometric groups to which he belongs onto the next, higher plane, the industrial and cultural collectives. The sociometric matrix is now superseded by the cultural matrix, in the case of an individual, called the cultural atom; the instruments are now role techniques and the sociodrama. The task of the next higher plane is the integration of the cultural matrices into ethical and cosmic collectives, a task of the greatest importance but full of irrational difficulties in a critical period like ours, in which the higher values of the universe and of life itself have decayed and must be reformulated. The instrument which approaches such problems is the "axiodrama", the drama of values.

4. *The Auxiliary Ego Process.* The function of the auxiliary ego is living through the subjectivity of the patient and identifying himself with all the actions, feelings and thoughts of the client. The client is the primary ego; auxiliary ego means being an auxiliary, an extension of the client's self, a helper, not as the case worker sees it, but as the client sees it. *The primary function of an auxiliary ego is productive, imaginative subjectivity, in the direction of the subjectivity of the client. Spontaneity begets counter-spontaneity.* The spontaneity of the case worker or auxiliary ego will evoke the counter spontaneity of the client and vice versa. This process which liberates spontaneity is called the warm up; it removes symptoms as anxiety, irritations and tensions. The analytical objectivity of a psychiatric social worker may or may not be necessary. It is secondary, however. Often it is harmful. In the counseling of two persons involved in a problem his function consists in having alternating sessions with the two partners, always bringing to each party an accurately subjectivistic report of what each of the partners does and says in regard to the other. The auxiliary ego is more than a psychoanalyst of the client's case, and more than a helper. He is like the client's *double,* of an extreme sensitivity to the ongoing processes in the client's mind. He is like a psychodramatic role player on the reality level. At times he is wiser, at times more stupid, at times he is more fearful, at times more courageous than the client, depending upon what would mobilize the client's greatest social pro-

ductivity. At times the two partners in the conflict are brought together to a meeting to face each other and work out their problem in the presence of the case worker; this is the seed for a psychodrama. It is obvious that the auxiliary ego technique in the interview process with clients takes the position of the extreme left when compared with the position of the authoritarian psychoanalytic case worker on the extreme right, who tries to battle through the transference relationship, and the Rankian approach which holds approximately the middle position.

5. *The Vehicles.* Vehicles are devices advantageous for the effective attainment of a goal. The automobile is a physical vehicle for rapid locomotion. Other illustrations of physical vehicles are the refrigerator or artificial teeth. Similarly, there are religious, therapeutic and diagnostic vehicles. *Adequate vehicles are so structured that they help the warm up of the clients to full production.* The church is a religious vehicle; it transforms individual believers into an ethical collective. The couch of the psychoanalyst, the "therapeutic" chair of the counselor, the pictures of the Thematic Apperception Test are such vehicles, each structured for a different warm up. Vehicles should be differentiated from techniques. The vehicle is a specific, concrete device, it can be used for numerous operations. A technique is one particular operation. The most profound theoretical approach is helpless in practice without vehicles which are able to mobilize the autonomous productivity of the client. The deficiencies of the psychoanalytic approaches to social casework lie in their unimaginativeness. They work in a void, or with defective vehicles as the couch.

The crux of the sociometric approach to social casework lies in having made available to clients a number of useful group and action vehicles. One is the *sociogram,* a simple but effective aid in the charting of the sociometric matrix of the client; the other is the *psychodrama stage*; the third is the *therapeutic group theatre* which combines the stage with an auditorium, especially structured for audiodramatic activities. For every step in the client's finding of himself corresponding vehicles have been invented, sufficiently flexible to permit various techniques to be used within them. As the life of the individual unfolds step by step from the sociometric groupings, the occupational, economic, political, cultural and religious collectives, vehicles emerge for testing and treating the normalogies as well as the pathologies of these powerful realities in which the individual is enmeshed; they cannot be left to chance or to the hope of automatic repair, they must be made available to the client.

NOTE ON COHESION IN SOCIAL GROUPS

J. L. MORENO

Because of the growing attention which is given to the problem of social cohesion in recent literature and the corroboration of my hypotheses a recapitulation of the position which I have taken in the course of years may be useful.

1) Cohesion has been defined by me as "the forces holding the individuals within the groupings in which they are." SOCIOMETRY, Vol. I, 1937, p. 371.

2) As to the relation of cohesion to group structure "certain social configurations have a structure which may place them nearer to the chance level, other social configurations may have a structure which places them nearer the optimum of cohesion. In accordance with this hypothesis, a group of primates or a group of human infants should rank lower on the scale than, for example, a group of human adults." SOCIOMETRY, Vol. VIII, 1945, p. 75.

3) As to the frame of reference for *all* forms of social cohesion "The deviation of the actual groups from chance groups (and the changes from poorly structured to highly structured groups) must be ascribed to a specific factor: tele. The cohesion (C) of a group is therefore a function (f) of tele (T), C=fT. (J. L. Moreno's discussion of cohesion in Paul H. Hoch, *Failures in Psychiatric Treatment*, p. 130, Grune & Stratton, 1948.)

4) The degree of cohesion of the primary group increases with the number of criteria (the aims or goals around which associations are formed) around which its participants develop cohesiveness. (*Who Shall Survive?*, 1934, p. 144-146.)

5) The measurement of changes in group structure and cohesion in longitudinal series is necessary in order to put the therapy of groups on a rational basis. By comparative studies of groups at different points in time we learn of the degree of cohesion related to the greatest therapeutic benefits for them, i.e., the *optimum* cohesion.

A REVIEW OF "SOCIOMETRY IN FRANCE AND IN THE UNITED STATES"

EDITED BY GEORGES GURVITCH

Sociometry gets at the "insides" of group life and discovers what makes the group "tick" and how it may be adjusted to provide more satisfying interpersonal relationships for the members of the group. Moreno, who fathered the development of the science of sociometry since the early part of this century, has lived to see the day when sociometry has elicited a widespread interest among scholars in sociology, social psychology, psychology, psychiatry, and among practical workers in schools, communities, industries, and armies. Sociometry has come of age.

A landmark and testimony to the maturity of sociometric science is the new volume, *Sociometry in France and the United States,* edited by Georges Gurvitch, of the Faculte des Lettres of the Sorbonne, which is distinguished for its research, as well as its theoretical contributions to sociometry.

To begin with research, we find that Paul H. Maucorps, of the Centre d'Etudes Sociologiques (Paris), reports on "A Sociometric Inquiry in the French Army." In this splendid article Maucorps shows many ways in which careful sociometric work has contributed to the use of the "teamwork system" in schools for regular army officers. Of special interest is a clever adaptation of the true sociometric test motivated by the selection of team members for a group examination of twenty-four hours' duration at the end of an extended training program. Results are reported graphically and mathematically. Jennings has written a comprehensive review of the military use of sociometric and other tests in Great Britain, France, Germany, and the United States.

Other valuable research articles are published in this book. Bengt Danielsson, of the University of Washington, has written a study in sociometric anthropology entitled, "Some Attraction Patterns Among Jibaro Indians," (Western Amazonas). Danielsson does a splendid job of sociometric reporting with consequent locating of basic sociological patterns in this primitive community. Also first-rate is the "Sociometric Analysis of Class Status in Rural Costa Rica," written by Charles P. Loomis and Reed M. Powell, of the Michigan State College. The study of "Attraction Patterns in a University" by George A. Lundberg and Lenore Dickson shows that *propinquity* is "the prior or dominant factor which largely determines the positive in group indices. . . ." Henry S. Maas presents the

results of careful research of "Non-verbal Validation of Group Changes in Social Attitude through Sociometric Choice."

The book includes a number of highly significant theoretical and evaluational studies in sociometry, the most important of which is on "Microsociology and Sociometry" by Georges Gurvitch. Gurvitch emphasizes the importance of the "we," or group, as a "genuine collective unit" and proposes some original adaptations of the sociometric test to "find out the various 'we's' within a group." This type of study Moreno and Gurvitch coined the same term *microsociology;* but microsociology and sociometry are closely related. Says Gurvitch, "Sociometry without microsociology would become a vacuum, and microsociology without sociometry would become blind."

Rene Zazzo, of the School of Higher Studies in the Sorbonne, presents in his "Sociometry and Psychology" a carefully thought-out study of the relationships among psychology, sociometry, and microsociology. And Leopold von Wiese of the University of Cologne, presents a fine analysis of Moreno's "Who Shall Survive." Paul E. Johnson discusses the relation of sociometry to theology. Sorokin contributes a brilliant evaluation of Moreno's spontaneity-creativity theory.

To sum up the volume, Moreno reviews the analyses of his theories and shows how sociometry can incorporate numerous penetrating suggestions and go forward to the study of the open community to create a social order "worthy of the highest aspirations of all times."

As numerous research studies show, sociometry has become much more than interesting theory or entertaining research; for much validating research has shown that sociometry studies social reality. In this issue there appears the highly significant report of validation made by Robert J. Wherry and Douglas H. Fryer under the title of "Buddy Ratings: Popularity Contest or Leadership Criteria?" Factor analyses show that buddy (sociometric) ratings on officer candidates "appear to be the purest measure of 'leadership'."

Sociometry has come of age! *Sociometry in France and the United States* is a landmark in the development of the science of sociometry!

LESLIE D. ZELENY

Current Sociometric Books and Sociometrically-Oriented Literature Appearing in Other Journals

Bonney, Merl E. "A Study of Friendship Choices in College in Relation to Church Affiliation, In-Church Preferences, Family Size, and Length of Enrollment in College." *J. of Social Psych.*, May, 1949, 29: 153-166.

Caplow, Theodore, and Forman, Robert. "Neighborhood Interaction." *Amer. Sociological Rev.*, June, 1950, 15: 357-366.

Kephart, William M. "A Quantitative Analysis of Intragroup Relationships." *Amer. J. of Sociology*, May, 1950, 6: 544-549.

Sheimo, S. L.; Paynter, J.; and Szurek, S. A. "Problems of Staff Interaction with Spontaneous Group Formations on a Children's Psychiatric Ward." *Amer. J. of Orthopsychiatry*, Oct., 1949, 19: 599-611.

Shartle, Carroll L. "Leadership and Executive Performance." *Personnel*, March, 1949, 25: 370-380.

Stogdill, Ralph M. "Leadership, Membership and Organization." *Psychological Bulletin*, Jan., 1950, 47: 1-14.

White, James E. "Research in Community Leadership." *Amer. Sociological Rev.*, Feb., 1950, 15: 50-60.

Thibault, John. "An experimental study of the cohesiveness of underprivileged groups", *Human Relations*, Vol. III, No. 3, 1950, p. 251-78.

Back, Kurt; Festinger, Leon and associates. "The Methodology of Studying Rumor Behaviour", *Human Relations*, Vol. III, No. 3, 1950, p. 307-12.

Festinger, L.; Schachter, S.; and Back, K. "Social Pressures in Informal Groups: A Study of a Housing Project." Harper: New York, 1950. For further orientation on the theory of communication-networks, on spontaneous and experimental rumor, and on theory of *cohesion*, see J. L. Moreno, "Who Shall Survive?" (1934), pp. 256-266, "Foundations of Sociometry" (1941), Vol. V, pp. 27-29, and "Sociometric Measurement of Social Configurations," Sociometry Monograph No. 3 (1938).

Fleming, C. M. "Adolescence. Its Social Psychology with an Introduction to recent findings from the fields of Anthropology, Physiology, Medicine, Psychometrics and Sociometry." New York: International Universities Press Inc., 1949.

Katz, Leo. "The Distribution of the Number of Isolates in a Group." Institute of Statistics, University of North Carolina, 1950.

Koskenniemi, Matti. "Comments on Group Work in School." Helsinki, 1950.

Dodd, Stuart Carter. "The Interactance Hypothesis." *Amer. Sociological Rev.*, Vol. XV, No. 2, 1950.

Announcements

SOCIOMETRIC INSTITUTE INC.

101 Park Avenue, New York 17, N. Y.

Telephone: Murray Hill 3-1626

In cooperation with the

BOARD OF SUPERINTENDENTS

OF THE

BOARD OF EDUCATION, NEW YORK CITY

announces the

WORKSHOP

ACTION AND GROUP METHODS

IN-SERVICE CREDIT

COURSE ENTITLED

"GROUP METHODS IN EDUCATION"

Executive Director, J. L. Moreno; *New York Advisory Board,* John Dewey, Columbia University; Lawrence K. Frank, Carolyn Zachry Institute; George Gallup, American Institute of Public Opinion; Jacob Greenberg, N. Y. C. Board of Education; William H. Kilpatrick, Columbia University; Paul F. Lazarsfeld, Columbia University; Robert Lynd, Columbia University; Margaret Mead, American Museum of Natural History; Gardner Murphy, C. C. N. Y.; Frank Stanton, C. B. S.; *Staff of Instructors,* J. L. Moreno; Leona M. Kerstetter, Associate; Zerka T. Moreno, Associate; Don Leveridge, Coordinator of Education.

LEADERSHIP TECHNIQUES

The democratic concept of leadership implies a wide participation in discussion and decision making. It requires active techniques and a sensitivity to group and individual needs. It is furthered by an understanding of the dynamics of groups. Group process techniques are useful in staff meetings, committee work and classroom teaching: in the strengthening of democracy.

The principles and techniques as developed by Dr. J. L. Moreno and other pioneers during the last thirty years have been adapted by ever increasing numbers of teachers, administrators, social workers and psychologists.

SOCIODRAMA AND ROLE PLAYING

The working out of situations in action for educational and creative purposes.

Illustrations: 1) Dealing with human relations problems; 2) working out in action real situations for teaching purposes—early childhood, elementary subjects, the social studies, the languages, mathematics, reading, adult education; 3) resolving conflict situations among adults and childen.

SOCIOMETRY

The study of the structure of groups—the personal relations between group members in working together, studying together, playing together, etc.

Illustrations: 1) In assigning children to projects a teacher wishes to group them for the greatest cooperative productivity and personal development; 2) a guidance worker wishes to build up the social relations of rejected and isolated pupils.

The philosophy of modern education stresses total personality growth and group participation. They are functions of the vitality and meaningfulness of the learning situation. Therefore, sociometry, and sociodrama are concerned with practical means of developing the spontaneity and initiative of the educator and in training him for creative roles. In these creative roles, a teacher prepares learning situations which draw upon the widest potentialities of interest and productivity of the participants.

FALL SEMESTER
September 26, 1950 - January 12, 1951

Instructor—DON LEVERIDGE

Section a) *Tuesdays* 3:45-5:25 starting Sept. 26, 1950.
The Auditorium, Sachs Quality Stores, 3rd Ave. & 150th St., Bronx.

Section b) *Wednesdays* 3:45-5:25 starting Sept. 27, 1950.
P. S. 75, N. End Ave. & 96th St., Manhattan.

Section c) *Thursdays* 3:45-5:25 starting Sept. 28, 1950.
Technical High School, Fort Greene & So. Eliott Pls. & Dekalb Ave.

Section d)
Sociometric Institute, time and day to be announced.

NOTE: Should Sections a), b), c), and d) be closed due to large enrollment, other sections with available instructors will be organized during registration period as follows:

Instructor—ZERKA T. MORENO

Section e) *Fridays* 3:45-5:25 starting Sept. 26, 1950.
Sociometric Institute, 101 Park Avenue, Room 327.

Instructor—LEONA KERSTETTER

Section f) *Saturdays* 3:45-5:25 starting Sept. 30, 1950.
Sociometric Institute.

Instructor—J. L. MORENO

Section g) *Mondays* 3:45-5:25 starting October 2, 1950.
Sociometric Institute.

Other sections to be opened by Instructors EYA RUDHYAR and EDGAR BORGATTA.

IN-SERVICE CREDIT GRANTED

Credit: 2 points; Tuition: $30.00 (including registration).

Special Rate for Teachers of New York City Schools—$15.00

Registration on First day of Attendance at Location of Instruction.

The SOCIOMETRIC INSTITUTE was incorporated by the State of New York in 1942 for the teaching and training in group and action methods. It is located at 101 Park Ave., New York City, and has a branch at 259 Wolcott Ave., Beacon, New York. It enrolls students throughout the year and is the oldest school of this type, specializing in the teaching, training and research into: *Human Relations Methods; Sociodrama; Sociometry; Cooperative Pupil Planning; Group Leadership Techniques* and their *application to everyday classroom and staff situations.*

J. L. MORENO, Founder of the Sociometric Institute, 1942. Editorial Chairman of "Sociometry," Journal of Interpersonal Relations and "Group Psychotherapy," Journal of Sociopsychopathology and Sociatry.

LEONA M. KERSTETTER, formerly Instructor of Sociology, Psychodrama and Sociometry, New York University, 1947-1949; now with Hunter College.

ZERKA T. MORENO, Associate Director, Psychodramatic Institute and Training Instructor since 1942.

EYA RUDHYAR, Assistant Psychodramatic Institute, Beacon, N. Y.

DON LEVERIDGE, New York Educational Director, National Conference of Christians and Jews 1948-1950, previously Instructor in Social Foundations of Education, Teachers College, Columbia University.

SOCIETY OF GROUP PSYCHOTHERAPY AND PSYCHODRAMA

The urgency of the world crisis requires a concerted effort to prepare for the scientific development and the widest application of group and action methods.

The *Society of Group Psychotherapy and Psychodrama,* (Chairman, J. L. Moreno, M.D.) founded in 1943, is extending its activities and invites you to become a member. See application blank enclosed. (Membership in the American Psychiatric Association makes applicants automatically eligible for membership in the Society of Group Psychotherapy and Psychodrama.) Dues: $3.50 per annum, including subscription to the journal Group Psychotherapy. A conference of members and contributing editors of the journal to coordinate the old society with the new policy of the journal is planned for October, 1950 (exact date to be announced).

Group Psychotherapy, Journal of Sociopsychopathology and Sociatry, a quarterly published by Beacon House, Beacon, New York. Subscription Rate: $7.00 per annum, foreign postage $1.00 additional. This journal is now in its third year of publication. Its Board of Contributing Editors has

been enlarged to include the following: Drs. Nathan W. Ackerman, Vernon C. Branham, Joshua Bierer (England), E.A.D.E. Carp (Netherlands), S. H. Foulkes (England), Jerome D. Frank, Martin Grotjahn, Wilfred Hulse, J. W. Klapman, Rudolf Lassner, Delbert C. Miller, Leopold von Wiese (Germany), Alexander Wolf, Guerriero Ramos (Brazil), H. Teirich (Austria).

Upon the appeal of J. L. Moreno about *twelve hundred Fellows and Members* of the American Psychiatric Association have joined in a petition for a *Section on Group Psychotherapy* within the Association. The Council will decide upon this issue during its November meeting. Members of the American Psychiatric Association can still join the petition for the section. Please write to J. L. Moreno, Beacon, New York.

A sectional meeting or symposium on Group Psychotherapy is under consideration for the next annual meeting, May, 1951, of the American Psychiatric Association. This occasion will also commemorate the anniversary of twenty years of Group Psychotherapy within the Association since the first recommendations in its behalf at the Toronto meeting in 1931. Send us papers on Group Psychotherapy or Psychodrama that are now ready or inform us of any project in the field.

A *Round Table Conference on Psychodrama* will take place during the American Psychological Association meeting at Penn State College on September 8th.

The *Sociometric Institute* at 101 Park Avenue, New York City is preparing an extensive program of seminars and workshops in group psychotherapy, psychodrama, sociodrama and sociometry. The fall term begins September 15th. (Write for catalogue.)